SYSTEMS FOR HANDLING GROCERY PRODUCTS FROM SUPPLIER TO DISTRIBUTION WAREHOUSE

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On January 24, 1978, four USDA agencies—Agricultural Research Service (ARS), Cooperative State Research Service (CSRS), Extension Service (ES), and the National Agricultural Library (NAL)—merged to become a new organization, the Science and Education Administration (SEA), U.S. Department of Agriculture.

This publication was prepared by the Science and Education Administration's Federal Research staff, which was formerly the Agricultural Research Service.

PREFACE

This study was conducted under contract with the Paul F. Shaffer Co., management consultants, Miami, Fla.

Appreciation is extended to the following supplier and wholesale-retail food distribution companies for use of their facilities to measure productivity in loading and unloading railcars and trucks: Armour-Dial, Inc., Montgomery, Ill.; Bama, Division of Borden, Inc., Birmingham, Ala.; Beverage Canners, Miami, Fla.; Bruno's, Inc., Birmingham, Ala.; Chatham Super Markets, Warren, Mich.; Hill Brothers, Miami, Fla.; Husky Co., Ocala, Fla.; Kellogg Sales Co., Battle Creek, Mich.; Pillsbury Co., Minneapolis, Minn.; Procter and Gamble Distributing Co., Cincinnati, Ohio; Publix Super Markets, Miami, Fla.; Red Owl Stores, Hopkins, Minn.; Scott Paper Co., Mobile, Ala.; Super Valu Stores, Hopkins, Minn.; and Transolidate Service, Huntington, W. Va.

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SYSTEMS FOR HANDLING GROCERY PRODUCTS FROM SUPPLIER TO DISTRIBUTION WAREHOUSE

By John C. Bouma and Paul F. Shaffer[1]

SUMMARY

Supplier and distribution warehouse personnel are usually more concerned with how fast railcars or trailers are loaded and unloaded than with the total cost of the food distribution system for dry grocery products. It is essential that all the costs associated with loading and unloading, i.e., labor, equipment, materials, damage, and dunnage, be included in the total cost analysis for each method of shipment. It is also important that the shipping methods be compatible for the supplier and the distribution warehouse. Since the lowest cost loading method is not always the lowest cost unloading method, the total system cost is the most relevant.

In railcar shipment, the lowest cost system was shrink film wrap at $18.40 per 1,000 cases and $0.681 per 1,000 pounds followed by the pallet system at $28.16 per 1,000 cases and $0.969 per 1,000 pounds. There was little difference in the cost of manual, slipsheet, and clamp loading. Reasons for the low cost of the shrink film wrap and pallet systems were elimination of the need for dunnage and the pallet exchange program. Slipsheets should be strong to reduce the damage in unloading.

Many industry executives predict that the slipsheet with shrink film wrap will become the most common method of rail and truck shipment because of the greater labor and equipment productivity in loading and unloading, reduced damage, elimination of dunnage, and savings in cardboard required for cases.

Unitized shipment by truck is not used to the extent currently utilized by rail except for backhauls. Pallets are not used extensively in truck shipments because of the cost and inconvenience when there is no pallet exchange program. Pallets with an exchange program were the lowest total cost method of shipment at $0.599 per 1,000 pounds and next to the lowest cost at $16.19 per 1,000 cases. Without the exchange program, the cost of palletized shipments was nearly doubled—$31.90 per 1,000 cases and $1.267 per 1,000 pounds. Shrink film wrap, excluding freight charges for the pallet, cost the least at $15.35 per 1,000 cases and next to the lowest at $0.748 per 1,000 pounds. Clamp loading on slipsheets and slipsheet unloading cost $25.14 per 1,000 cases. The pallet, shrink film wrap, and slipsheet systems each cost less than half the $50.40 per 1,000 cases for manual loading and unloading, which was the highest cost system.

Problems in loading and unloading both railcars and trucks reduce the efficiency of shipping and create conflicts between the supplier and the distribution warehouse. Many suppliers have unitized handling and storage systems that do not require pallets and thus reduce the advantage of a pallet shipment for them. When unit loads are not fully secured or dividers used to prevent shifting in transit, problems occur in unloading. The supplier may ship unit loads with more layers than can be placed in the warehouse racks, or he may mix items in a unit load. This results in the need to repalletize at the distribution warehouses. Many warehouses use the smaller 40- by 32-inch pallet for low volume items, resulting in many 48- by 40-inch unitized loads having to be transferred to the smaller pallet. The repalletization on small pallets increased the cost of unloading by 52 percent or $6 per 1,000 cases. If the warehouse were to convert to the 48- by 40-inch pallet, the added annual cost for racking and space was more than $20 per 1,000 cases in one medium-size and one large firm. Distribution warehouses with many

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slow moving items would appear to have lower costs if they absorbed the additional cost of repalletization. The dry grocery distribution system appears to have too many built-in limitations for the introduction of a second size standard pallet.

The methods and crew sizes have an important bearing on unloading costs. A checker who performs no other tasks, but could be a working member of the unloading crew or an additional unloader, adds to the cost. In one instance not included in this analysis, a handstacked rail load cost 3½ times as much in labor to unload as the average of studies included here because of unsatisfactory methods and a larger crew than was necessary. The same condition occurred with a slipsheet rail load.

Unitized loading and unloading of truck shipments cost half the amount of manual loading and unloading. The lowest cost system per 1,000 pounds was pallet loading and unloading if freight charges for the pallet were excluded. Shrink film wrap had the lowest cost per 1,000 cases, excluding freight charge for the pallet. Use of slipsheet and clamp loading and unloading is limited in truck shipments, although savings are possible with these systems.

Improved unloading efficiency at the distribution warehouse can be achieved by (1) scheduling truck receipts, (2) using unitized unloading, (3) providing sufficient temporary storage space on the dock, (4) employing proper materials-handling equipment, and (5) having sufficient dock personnel to check the merchandise. By scheduling truck receipts at one firm, savings in waiting time totaled 6.20 minutes per truck, with savings of $0.97 per truck.

Additional savings in unitized shipping can be achieved through improved coordination between the distribution warehouse buyers and suppliers in terms of order and shipping quantities. Additional savings may also be achieved (1) with unitized consolidated shipments from one supplier to two or three distribution warehouses located within a metropolitan area in order to achieve lower transportation rates, (2) with full load compared with less than truckload, and (3) with unitized loading and unloading.

INTRODUCTION

The pressure on the food distribution industry to find more efficient ways of moving their products from the manufacturer to the retail food store is ever present. This pressure comes from consumers, whose food purchases are an increasing and major item in their budgets, and from distributors, whose expenses are ever increasing for labor, equipment, materials, transportation, inventories, and other operating costs.

These problems are not easily resolved, since the average warehouse handled over 7,000 items in 1975,[2] excluding many items delivered directly to supermarkets. The food distribution system demands a tremendous communication and supply network between the suppliers, warehouses, and retail food stores. An efficient system can only develop when the efforts of the suppliers, carriers, and warehouse distributors are directed toward the common objective of lowest total system costs. For example, if the supplier can lower loading costs by shipping unit loads incompatible with the storage capabilities at the distribution warehouse, the receiving costs must not exceed the loading savings in order to reduce system costs. Additional receiving costs are incurred with incompatible unit loads by repalletizing to smaller pallets or by removing layers of cases so the unit load will fit in storage racks. Some suppliers warehouse products in floor stacks to eliminate pallet racking and conserve space. This procedure makes the use of certain unitized handling systems, such as pallets and slipsheets, more difficult and expensive, yet suppliers have a special challenge to provide compatibility with other methods used by carriers and distributors throughout the food distribution system.

The distribution warehouse must provide storage facilities based on product movement to minimize the cost of inventory and provide selection fronts for all items. Some warehouses therefore use the 40- by 32-inch pallet for slow moving items. As a result, receiving personnel must repalletize from the 48- by 40-inch standard unit load.

[2] WHOLESALERS' $48 BILLION SALES TOTAL REFLECTS MORE SOLID GROWTH. Prog. Grocer Mag. 55 (No. 4): 151-158. 1976.

When the supplier ships more than one item on a unit load, receiving personnel have to place the different items on separate pallets and the advantages of unitization can be lost. Conflicts in handling methods of the suppliers and warehouse distributors, unless resolved, can undermine the efforts to develop an efficient food distribution system. Carriers are interested in greater utilization of their equipment and minimization of loss and damage claims incurred in transporting grocery products. Having achieved such goals, the improvements should be measurable in reduced transit charges.

Although differences have occurred in the handling-system objectives of suppliers, carriers, and warehouse distributors, a brief review of the efforts toward unitization will reveal that progress has been achieved in the past decade. In the mid-1960's, rail and truck grocery shipments were handstacked on the floor of the carrier. Most distribution warehouses used the standard 48- by 40-inch wood pallet and a 40- by 32-inch pallet for slow moving items. Pallet racks and floor stacks were designed to handle both sizes of pallets. At the supplier level most of the unitization and storage were accomplished with a wide array of pallet sizes and by use of a forklift truck with clamp attachment.

Since the mid-1960's, the Grocery Manufacturers of America (GMA) and the wholesale and retail food trade associations have cooperatively adopted the 48- by 40-inch pallet and load size. Detailed specifications and guidelines for pallet exchange are now prepared by the Grocery Pallet Council (GPC). In cooperation with the carriers it has a working pallet exchange program. Thus the industry now has a standard pallet that can be used all the way from the supplier to the retail store. In addition, a pallet exchange program, pallet pools for the temporary storage of pallets, and various arrangements with the carriers for the return of empty pallets have been developed, but expansion of the program is needed.

As this program continues to develop and pallet standardization is used, manufacturers, carriers, and distributors continue to search for unitized shipping methods that will make their handling operation better or at least compatible with pallet receiving and storage at the distribution warehouses. This effort has led to the development of fiberboard slipsheets for loading and unloading. The 40- by 54-inch sheets are typically placed on the floor of the railcar or trailer during loading, and a forklift truck with clamp attachment moves the product from floor stacks and places it on the slipsheet. The product can also be placed on the slipsheet during the automatic unitization of cases as they come off the assembly line. At the distribution warehouse a forklift truck with a Pull-Pac attachment engages the lip of the slipsheet, pulls the unit load onto the tines of the forklift, transports the load to the dock, and then pushes the unit load onto a standard pallet. The shrink film unit load, typically placed on slipsheets or pallets, was developed as a method of securing the load during transit and speeding up the unloading at the distribution warehouse.

All the unitized shipping systems established compatibility with the standard 48- by 40-inch pallet at the warehouse and the handling system of the supplier. The effectiveness of the various shipping methods depends on their total system cost, including transportation, labor, equipment, materials, dunnage, and product damage. Progress has been made in reducing the costs of distributing grocery products largely because of the cooperation among the suppliers, carriers, and distributors.

OBJECTIVES

The first objective of this study was to measure the costs and determine the relative advantages and disadvantages of various systems for handling grocery products from suppliers to distribution warehouses. The second objective was to determine problems and recommend methods for their solution so as to reduce the overall cost of distributing grocery products. There are cost benefits for suppliers and distributors if current problems can be resolved, such as the tie and height of unit loads. A third objective was to determine the feasibility and possible benefits of a supplier-distribution warehouse program using unitized shipping with smaller units, such as 40- by 32-inch platforms. Finally the study was intended to provide research data to assist supplier and distribution warehouse management in deciding which handling system was most efficient for its use.

METHODOLOGY

To accomplish the objectives of the study, time and cost standards for labor and equipment were established for each of the following systems of loading and unloading grocery products in railcars and trucks: (1) *Manual* or *handstack*, (2) *pallet* – use of standard 48- by 40-inch GMA pallet, (3) *slipsheet* – 40- by 54-inch fiberboard slipsheet handled by forklift truck with a Pull-Pac attachment, (4) *clamp* – use of forklift truck with attachment to pick up and transport unit loads with squeeze-type pressure plates, and (5) *shrink film wrap* – plastic shrink or stretch film overwrap with product handled on pallets or slipsheets.

For each of these loading and unloading systems, time and cost standards for labor and equipment were also developed for the following product categories: (1) Products in glass, such as jellies, baby food, and salad dressing; (2) products of high density, such as canned goods, cake mixes, and boxed soap; (3) products in plastic containers, such as bleach, detergents, and shampoo; (4) paper products, such as bags, napkins, toilet and facial tissue, and towels; and (5) bagged products, such as charcoal, pet food, flour, and sugar.

The studies were conducted in nine supplier plants and six distribution warehouses.

The evaluation of the handling methods at the supplier's facility consisted of developing time and cost standards for labor and equipment for each product category and method of loading from the time the product was placed on the dock for loading until it was loaded and stabilized in the railcar or truck trailer. The standards were based on 1,000 cases, 1,000 pounds, and per load. The standards included movement of the product into the delivery vehicle, time and cost to secure or stabilize the load to prevent shifting in transit, and measurement of damage to the product during loading. The supplier's cost of unitizing the product and the cost of the loading platform were also included in the evaluation.

The cost of transporting grocery items according to product category by railcar and truck trailer was on a per load basis. The basis for comparison was a specified point of origin (Atlanta, Ga.) to a specified point of destination (Miami, Fla.). The cost of the pallet or other loading platform was included both in its shipment and its return.

Comparative time and cost studies for labor and equipment were developed at the distribution warehouse for unloading grocery items by specified product categories and methods of unitized shipment and when handstacked. This evaluation included (1) necessary preparation of the vehicle for unloading, (2) transportation of product to the dock staging area, (3) repalletizing layer quantities of product when the unit load would not fit into pallet racks or when more than one item was on the unit load and transferring the product to smaller pallets, (4) straightening unit loads caused by load shifting, and (5) measuring damage to the product.

The overall study included a minimum of two railcar and two truck trailer loads for each shipment system and product category when loads were available. Labor productivity studies were based on a standard elemental time basis, including a 15-percent fatigue allowance. Labor rates at both supplier plants and distribution warehouses varied from $3 to $9 per hour, including fringe benefits. To establish comparability in all studies, an average wage rate of $6 per hour was used. Any damaged case was assumed to be fully damaged and was valued at $8.

SUPPLIER SHIPMENT BY RAIL

In all the supplier plants studied, the product moved from packaging to the automatic unitizer and to storage. When the railcar was ready for loading, the forklift operator obtained unit loads from storage and either placed them on the dock or moved them directly into the railcar. To establish a fair comparison of the various handling systems, the automatic unitization, travel to storage, and travel to the dock area were excluded from the study. The time to engage a unit load was added to the loading time when the product was moved from storage directly into the railcar. Since all railcars were cleaned and prepared for loading when they were positioned at the dock, this time

TABLE 1.—*Estimated cost of ownership and operation for various types of materials-handling equipment used in loading and unloading grocery products in transport vehicles*

Type of equipment	Initial cost [1]	Salvage value [1]	Annual depreciation [2]	Annual interest [3]	Total annual fixed cost	Annual operating cost [2]	Total annual cost	Average life	Annual use	Average cost per hour [4]
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Years*	*Hours*	*Dollars*
Electric pallet jack	4, 700	0	940	176	1, 116	1, 560	2, 676	5	2, 960	0. 90
Electric low-lift counter-balanced forklift truck (4,000-lb capacity)	14, 000	1, 000	2, 167	525	2, 692	2, 350	5, 042	6	2, 986	1. 69
Electric forklift with Pull-Pac attachment (5,000-lb capacity)	20, 450	1, 860	3, 098	767	3, 865	1, 872	5, 737	6	2, 575	2. 23
Electric forklift with clamp attachment (5,000-lb capacity)	20, 900	1, 900	3, 167	784	3, 951	6, 049	10, 000	6	[5] 4, 000	2. 50

[1] From equipment manufacturers, including battery.
[2] From cooperating firms' internal records.
[3] Purchase cost divided by 2 equals average investment times interest at 7.5 pct equals average interest cost.
[4] Total annual cost divided by annual hourly usage.
[5] Equipment used for 2 shifts each day.

was excluded from the study. Firms not loading on pallets typically used the clamp lift, whether for manual, slipsheet, or film wrap loading. In most supplier plants the crew for unitized loading was a forklift operator, who was often the checker. The crew for manual loading consisted of a forklift operator who transported the product into the railcar and two or three men who handstacked cases.

The hourly cost for materials-handling equipment used in loading and unloading transport vehicles is shown in table 1. Unit loads were frequently shipped on platforms, such as pallets or slipsheets, and were secured while in transit by box-type separators (bumpers), corrugated divider sheets, or shroud film wrap over the unit load (table 2). Some suppliers used tape and banding to keep the unit load from shifting while in transit, and costs for these materials are shown in table 3.

TABLE 2.—*Cost of unit load platforms and load-securing devices for shipment of grocery products*

Item	Unit cost	Trips	Cost per unit load
	Dollars	*Number*	*Dollars*
Unit load platform:			
Pallet (48 by 40 in)[1]	9. 60	24	0. 40
Slipsheet (40 by 54 in)	. 40	1	. 40
Load-securing devices:			
Box-type separators (bumpers)	6. 00	16	. 375
Divider sheets (6 by 8 ft)	1. 00	1	1. 00
Unit load shroud film[2]	1. 00	1	1. 00

[1] GMA standard pallet at $6 and repair cost at $3.60.
[2] Includes labor, depreciation, and operating cost.

Manual Loading

Manual loading is the traditional method for loading and is the base for comparing other loading methods. It is used extensively when cubic space utilization is important in railcar loading (fig. 1). In some instances, the 14-foot area between bulkhead doors is manually loaded, although the rest of the car is loaded with unit loads on slipsheets (fig. 2). To operate the Pull-Pac forklift truck, a 14-foot area is needed.

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TABLE 3.—*Cost of tape and banding for unit loads of grocery products*

Item	Cost per foot	1 band		2 bands	
		Length	Cost per unit load	Length	Cost per unit load
	Dollars	*Feet*	*Dollars*	*Feet*	*Dollars*
Monofilament tape (½ in)	0.0049	18	0.09	30	0.15
Glassine tape (½ in)	.0032	18	.06	30	.10
String	.0062	16	.10	32	.20
Fabric strap (½ in) [1]	.0094	16	.15		

[1] Includes cost of bracket and strap.

The cost of manual loading was $17.11 per 1,000 cases and $0.532 per 1,000 pounds (table 4). Cost per 1,000 cases was nearly the same as pallet loading, and the cost per 1,000 pounds was second to the lowest cost method. Several factors contributed to the low cost of manual loading, including (1) the cases were moved into the railcar, which was convenient to the loading place, on pallets or with a forklift truck having a clamp attachment, (2) the loaders were experienced and often loaded two cases at a time, (3) in one firm one man loaded the car and thus eliminated crew delays, and (4) manual loading eliminated the need for and cost of platforms, load-securing devices, tape, and banding. In this study, the capacity of manually loaded cars in both number of cases and weight was con-

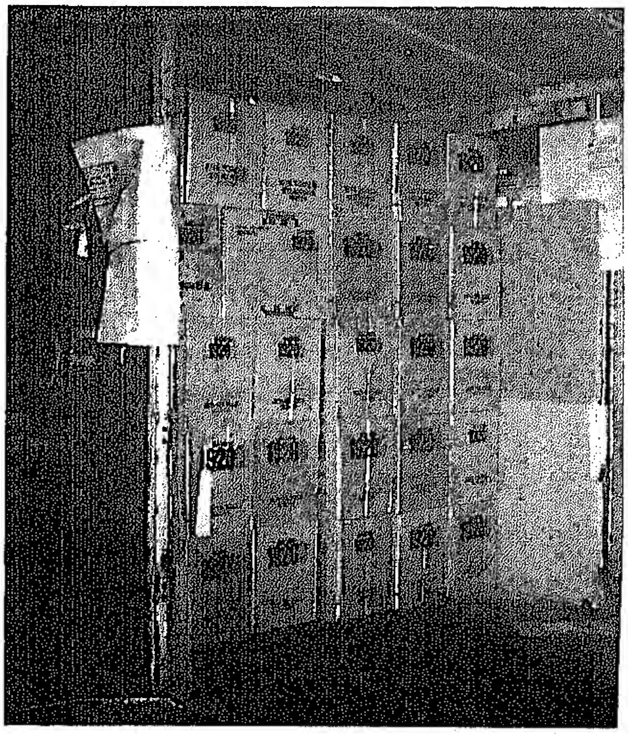

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FIGURE 1.—Railcar loaded manually to fully utilize available space.

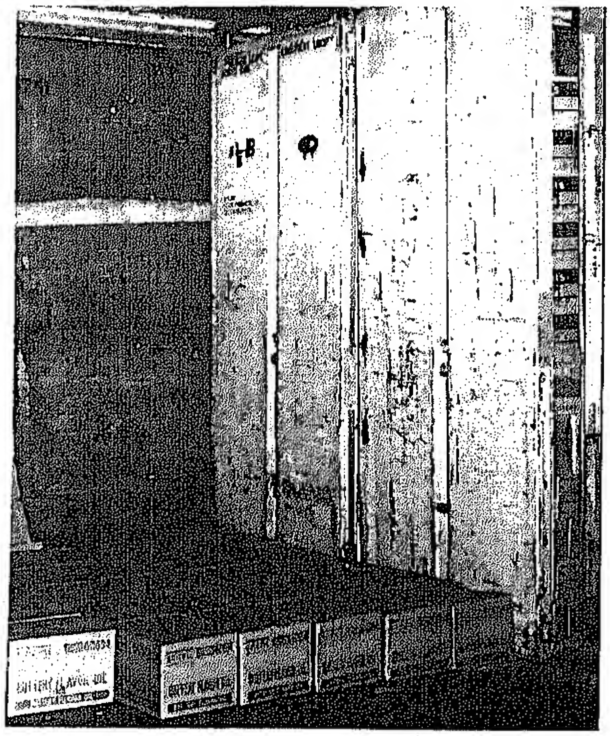

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FIGURE 2.—Groceries manually loaded between bulkhead doors in railcar.

TABLE 4.—*Cost comparison of 5 systems for loading railcars with groceries* [1]

Load size and cost element	Loading system				
	Manual	Pallet	Slipsheet	Clamp	Shrink film wrap [2]
Load size:					
Cases..........number..	1, 878	3, 012	1, 863	2, 476	3, 012
Pounds..........do....	60, 400	81, 600	54, 500	58, 300	81, 600
Cost element:					
Labor:					
1,000 cases..dollars..	14. 74	4. 06	5. 67	5. 53	4. 06
1,000 lb......do....	. 458	. 150	. 194	. 235	. 150
Equipment:					
1,000 cases...do....	2. 37	1. 15	2. 32	2. 30	1. 15
1,000 lb.....do....	. 074	. 042	. 079	. 098	. 042
Materials: [3]					
1,000 cases...do....		6. 13	7. 42	----------	6. 13
1,000 lb.....do....		. 226	. 254	----------	. 226
Dunnage: [4]					
1,000 cases...do....		5. 67	4. 36	3. 95	----------
1,000 lb.....do....		. 210	. 149	. 167	----------
Total:					
1,000 cases..do....	17. 11	17. 01	19. 77	11. 78	11. 34
1,000 lb...do....	. 532	. 628	. 676	. 500	. 418

[1] For detailed information on each load, see appendix tables 17 and 18.

[2] Based on pallet loading costs, excluding cost of dunnage, since dunnage is not used in shrink film wrap loading.

[3] Includes cost for unit load platform—pallets or slipsheets.

[4] Includes bumpers, film wrap, divider sheets, tape, string, and strap; dunnage cost for clamp loading assumes no application of mechanical unloading.

siderably lower than that of pallet loaded cars because of the light bulky nature of the products (table 4).

Pallet Loading

Use of pallets as a platform for shipping products in railcars has some advantages over other systems, including (1) use throughout the system from the supplier to the retail store as a captive system, (2) wide availability of materials-handling equipment to load and unload products, and (3) several existing arrangements with rail carriers for shipping and returning pallets without cost for their weight.

Pallet shipping is limited because many suppliers store products without pallets and must place them on pallets when the system is used. Because of the loss in cubic storage space and, in some instances, the need to use pallet racks, suppliers do not use pallets for storage. Pallet shipping is also limited because railcar dimensions are not compatible with the standard GMA size pallet, resulting in the need to secure products on the pallet by banding, tying (fig. 3), or using bumpers (fig. 4) to prevent them from shifting while in transit. Suppliers of light-weight items, such as paper and dry cereal, do not want to sacrifice the space used by pallets in the railcar and want to avoid the risk of tearing products packaged in bags, such as sugar, flour, and charcoal, from protruding nails and sharp edges on the pallet (fig. 5).

Pallet loading was not the lowest cost method because of the cost and repair of the pallet and materials needed to secure it in transit. The cost

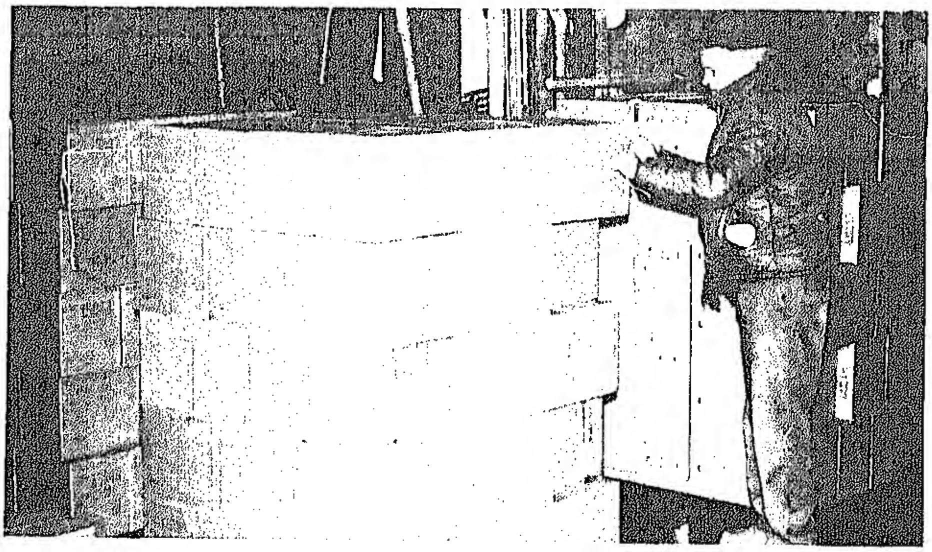

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FIGURE 3.—Securing top layer of a pallet unit load with heavy string.

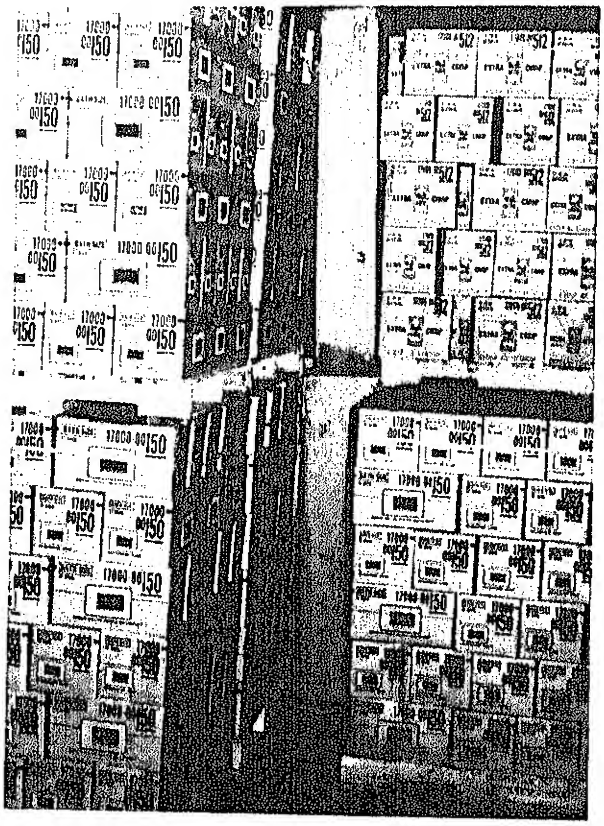

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FIGURE 4.—Box-type bumpers between pallet loads in center of railcar. Note banding on top layer of each pallet load.

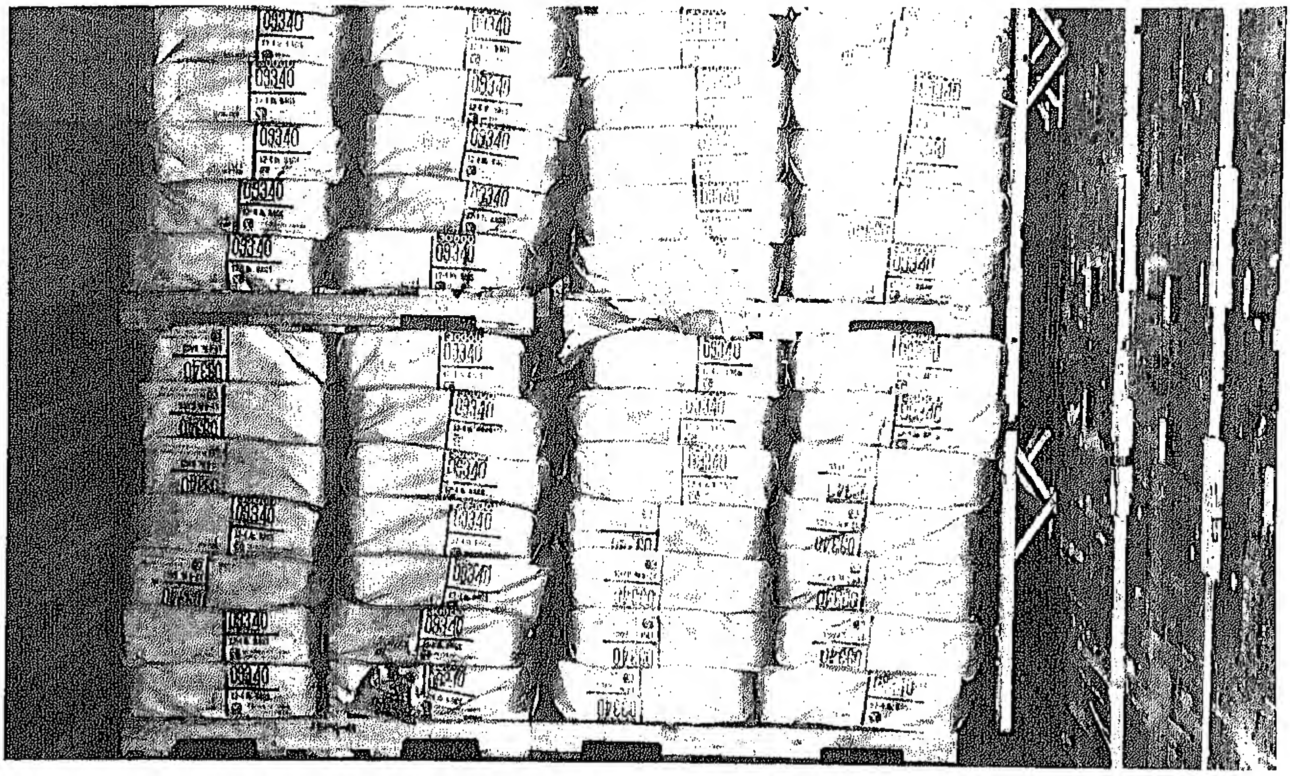

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FIGURE 5.—Bulky items packed in bags are difficult to load and stabilize on pallets.

of pallet loading was $17.01 per 1,000 cases and $0.628 per 1,000 pounds (table 4).

Pallet shipping costs will be greater for firms unable to arrange with the carriers for shipping the pallet and returning it without cost. Firms with captive or assigned railcars can return the pallets free of charge. They can also take advantage of the 5-1 rule, whereby they can return one of five railcars with the empty pallets. Thus if an average of 50 pallets is shipped per railcar, the receiver would accumulate and load 250 empty pallets in the fifth railcar for return to the supplier. Small suppliers may have to pay for the weight of the pallet in shipment if the total weight of the load, less the weight of the pallets, puts the car in a higher rate category. They would also have to arrange for the sale or return of the pallets.

Slipsheet Loading

The slipsheet permits better utilization of cubic space in the railcar and is ideal for such items as paper, cereal, bagged pet food, and charcoal. Studies were heavily weighted in favor of these items as shown by the lighter weight of slipsheet loaded cars (app. tables 17–18). Typically the slipsheets were placed on the floor or on top of a unit load by the clamp forklift operator just prior to loading (fig. 6).

Slipsheet loading at $19.77 per 1,000 cases and $0.676 per 1,000 pounds had the highest cost as shown in table 4. The labor cost for loading with slipsheets was 39 percent less than that for manual loading, but slipsheets (averaging 40 sheets per car at 40 cents each) and dunnage costs made it the most expensive loading method.

Clamp Loading

Clamp and slipsheet loading are similar operations because the clamp lift is normally used to place the product on slipsheets. The clamp lift is also used to move the product into the car for hand-stacking (fig. 7).

Clamp loading onto the floor of the railcar at $11.78 per 1,000 cases and $0.500 per 1,000 pounds was next to the lowest cost system. It had the lowest cost for dunnage except for manual loading (table

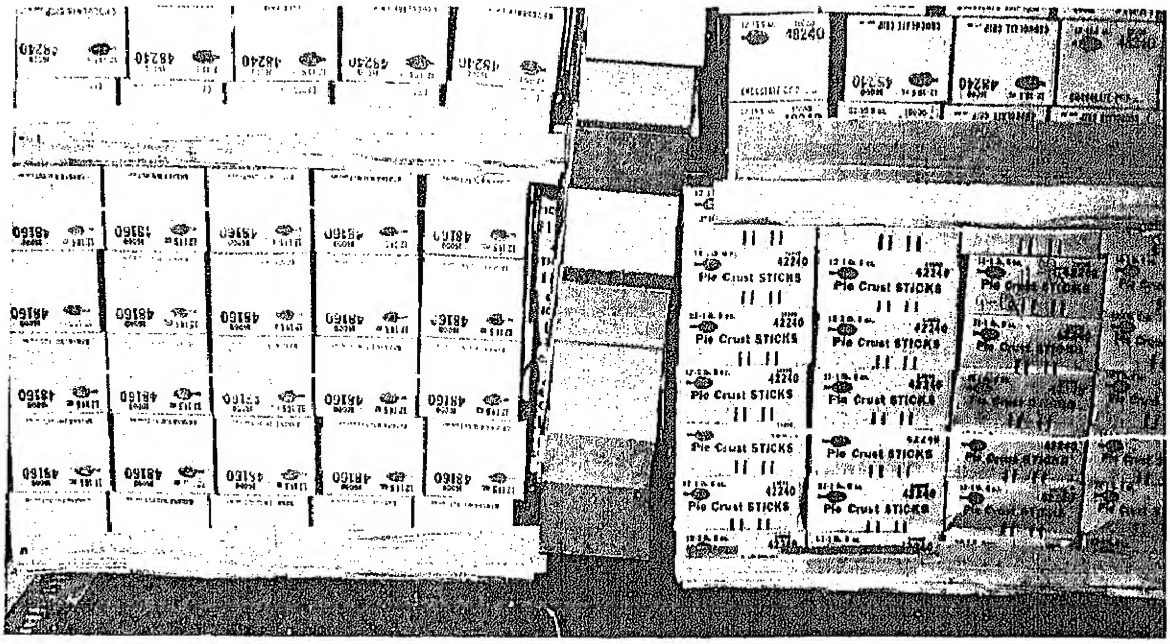

FIGURE 6.—Grocery products loaded on slipsheets in a railcar.

4). Other advantages include (1) it is especially effective for loading because it can use unit loads larger than the standard 48- by 40 inches, (2) it is compatible with palletless storage and handling in the supplier warehouse, (3) it reduces the need for dunnage, and (4) it increases the cubic space utilization of railcars.

Shrink Film Wrap Loading

Shrink film is used by some manufacturers to wrap individual cases known as tray pack (fig. 8). Tray pack cases have the same base as a regular carton plus a 1- to 2-inch lip around each side. They are wrapped with shrink film and moved through a heat tunnel resulting in a tightly wrapped case. Some manufacturers are using stretch film to wrap tray pack cases in order to reduce costs.

A savings of more than 34 percent in the cardboard surface area is accomplished with 2 tray pack cases of 12 No. 303 cans of food compared with a full case of 24 cans. Manufacturers indicate the savings in cardboard at 1976 prices are sufficient to meet the cost of film wrapping tray pack cases.

As shown in table 4, shrink film wrap loading of tray pack cases at $11.34 per 1,000 cases and $0.418 per 1,000 pounds was the lowest cost syst advantage of this system is elimination of t for dunnage, because the film wrap adequ cures the load in transit. Additional savi accomplished at the retail store because pe can stock shelves without handling each i dividually.[3]

[3] GREENE, A., and SHAFFER, P. F. TRAY PACK S SHELF STOCKING IN GROCERY STORES. U.S. Dept. A Mktg., May 1960.

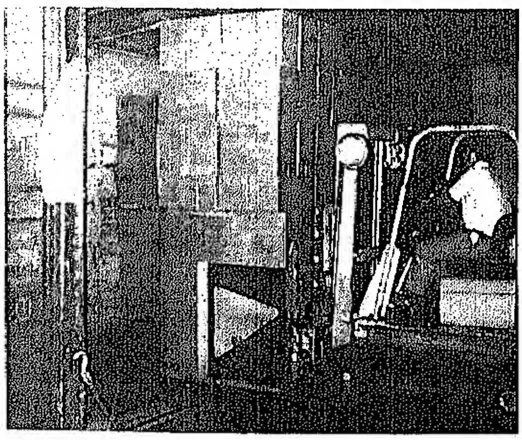

FIGURE 7.—Railcar being loaded by a clamp fo

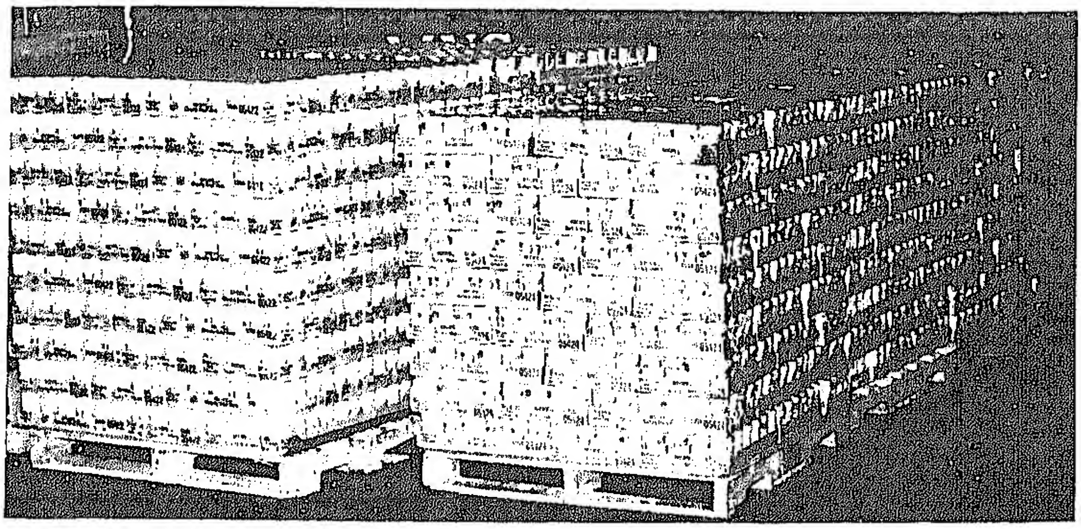

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FIGURE 8.—Individual tray pack cases wrapped with shrink film on pallets.

Shroud Film Wrap Loading

A shroud film is used to wrap the entire unit load. The use of a shroud film over the unit load is limited because of the cost of the film and heat shrinking. Studies were made of the loading of several railcars with shroud wrapped unit loads. Since the shroud wrapped products were placed on slipsheets or pallets, they were included in studies on slipsheet and pallet loading because the handling methods were the same. The cost for shroud film wrapping was $1 per unit load.

UNLOADING RAIL SHIPMENTS AT THE WAREHOUSE

Time studies of railcar unloading included such items as opening the car door, placing the dock board, obtaining materials-handling equipment and pallets if needed, removing the product from the car to the staging area, handling the dunnage, moving bulkhead doors and load-securing panels, loading empty pallets when necessary, removing the dock board, and closing the car door. Labor productivity in railcar unloading depended on such factors as number of cases handled per unit load out of the car, crew size and experience, methods and equipment used, arrival condition of the product in the car (whether the load shifted in transit), and adequacy of the dock staging area.

Manual Unloading

Manual unloading occurred most often in railcars where there were large numbers of items in small quantities. If the warehouse made extensive use of the 40- by 32-inch pallet for storage, it would order handstacked loads because the unit loads were smaller and there was no advantage in having the product on a 48- by 40-inch unitized platform. There was also some manual unloading in the center section of unitized loads. This occurred most frequently for slipsheet loads, since the Pull-Pac forklift required approximately 14 feet in which to maneuver in the car before unloading.

The most efficient method for manually unloading railcars was either for one man to work alone or for two men to work as a team. With a two-man crew, one would remove the loaded pallet with a pallet jack, the other would obtain an empty pallet, and together they would position cases on it (fig. 9). Productivity with a three-man crew was less than with a two-man crew or one man work-

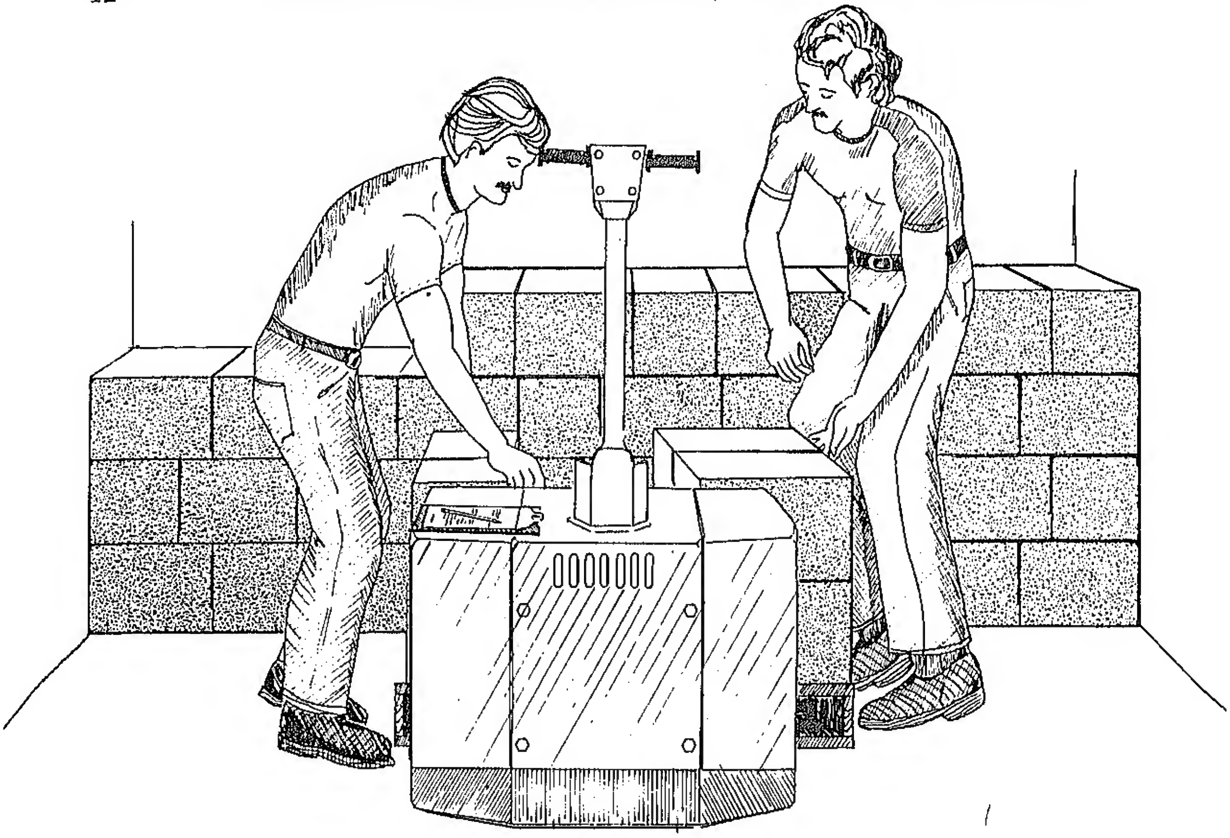


FIGURE 9.—Two-man crew manualy unloading railcar with pallet and pallet jack.

ing alone as shown in appendix table 19.[4] Manual unloading was the most costly method of receiving groceries in railcars as shown in table 5.

Pallet Unloading

Productivity in unloading palletized railcars ranged from 474 to 2,857 cases per man-hour as shown in appendix table 19. Some of the factors affecting productivity in unloading palletized products included the extent of load shifting in the railcar (fig. 10), the number of cases and weight of the pallet load, and the number of people assigned to the unloading crew. Load shifting was caused by (1) lack of dunnage to keep unit loads separated, (2) breaking of bands or string used to secure the load, and (3) lack of bulkhead doors in the car, causing a multiplier effect when the total load shifted.

[4] BOUMA, J. C., and LUNDQUIST, A. L. METHODS OF INCREASING PRODUCTIVITY IN MULTISTORY AND SMALL ONE-FLOOR GROCERY WAREHOUSE. U.S. Dept. Agr., Mktg. Res. Rpt. 142, 42 pp. 1956.

Additional factors affecting productivity not included in the comparison of methods were the need to (1) frequently reduce the height of the unit load by repalletizing one or more layers in order to put the pallet load into a pallet rack, (2) transfer products from the standard 48- by 40-inch pallet to a 40- by 32-inch pallet, and (3) repalletize when more than one item was on a unit load. These factors can be remedied through better communication between supplier and distributor.

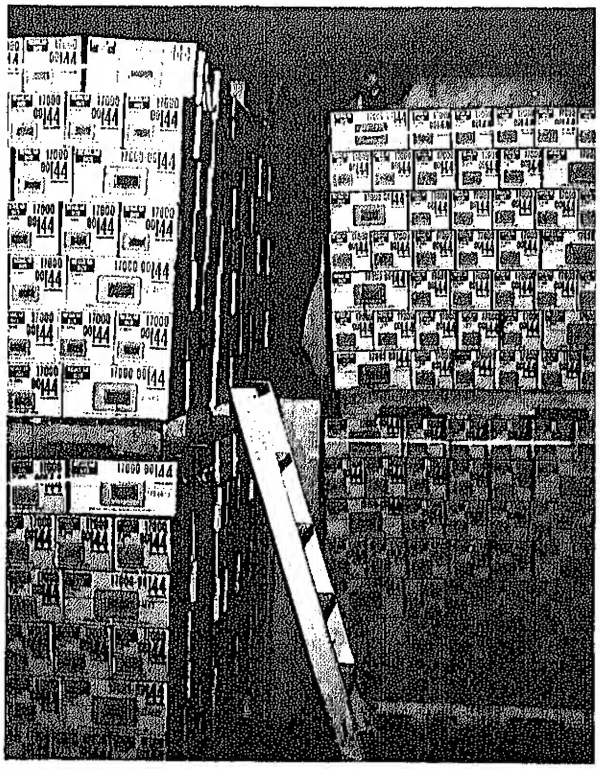
A railcar load of palletized product received in excellent condition is shown in figure 11. Pallet loads were stacked two high and banded, with cardboard placed on the top of each load to protect the cases. Bulkhead doors prevented load shifting.

As shown in table 5, pallet unloading at $11.15 per 1,000 cases and $0.341 per 1,000 pounds was next to the lowest cost system. This was partly due to the size of the average load in both cases and weight. Unloading productivity was at the rate of 900 cases per man-hour (app. table 19).

TABLE 5.—*Cost comparison of 4 systems for unloading railcars with groceries* [1]

Load size and cost element	Unloading system			
	Manual	Pallet	Slipsheet	Shrink film wrap
Load size:				
Cases..........number...	1, 542	2, 369	1, 402	1, 985
Pounds..........do....	56, 500	77, 400	51, 100	53, 300
Cost element:				
Labor:				
1,000 cases......dollars...	26. 42	9. 12	13. 08	5. 95
1,000 lb..........do....	. 730	. 279	. 358	. 221
Equipment:				
1,000 cases.........do....	1. 87	1. 28	2. 13	1. 11
1,000 lb..........do....	. 052	. 039	. 058	. 042
Damage:				
1,000 cases.........do....	3. 08	. 75	6. 34	----------
1,000 lb..........do....	. 085	. 023	. 174	----------
Total:				
1,000 cases.......do....	31. 37	11. 15	21. 55	7. 06
1,000 lb..........do....	. 867	. 341	. 590	. 263

[1] For detailed information on each load, see appendix tables 19 and 20.

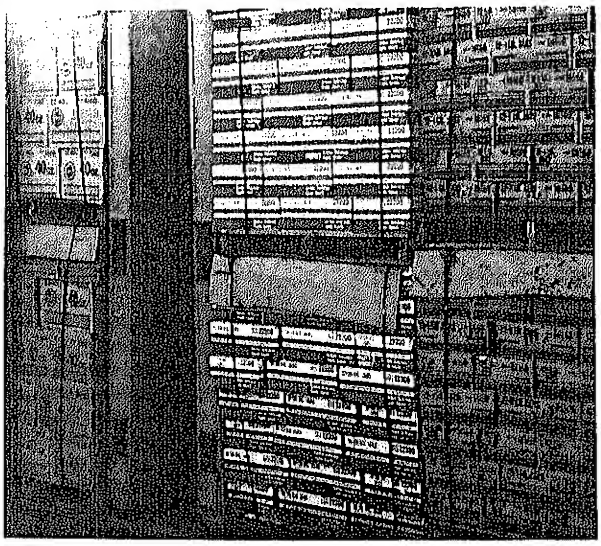


PN-5672

FIGURE 10.—Shifting of a palletized load in transit required that the forklift operator straighten the load before the pallet load was removed.

Slipsheet Unloading

As shown in appendix table 19, productivity in unloading railcars with the product unitized on slipsheets ranged from 149 to 1,474 cases per man-hour. Variation in unloading productivity can be attributed to arrival condition of the load, con-

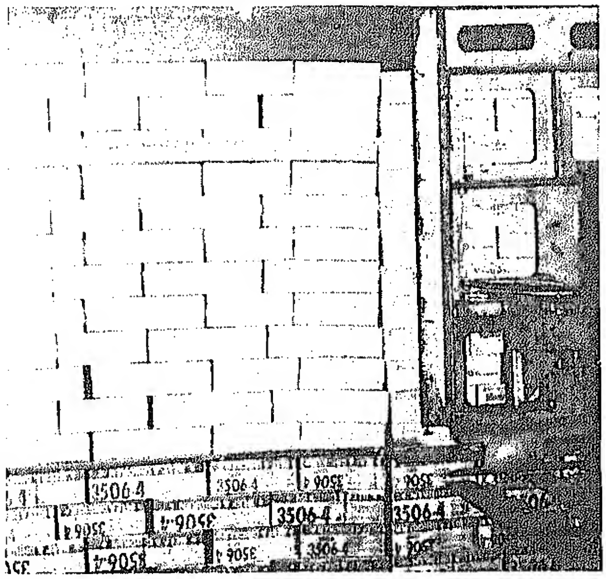


PN-5673

FIGURE 11.—Well-secured palletized load of grocery products.

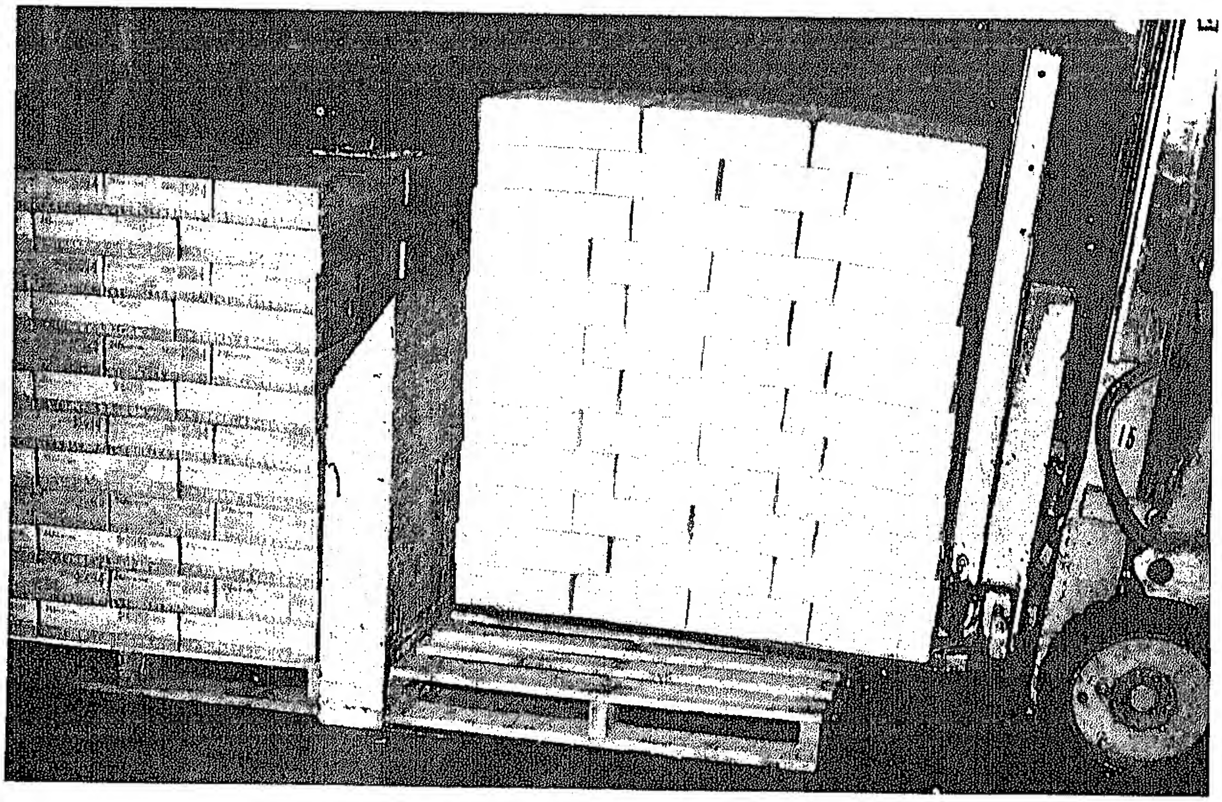
dition of the slipsheets, size of the crew, number of cases removed per trip from the car, and the methods used. The load with the highest productivity, study No. 22 (app. table 19), had a relatively high number of cases removed per trip from the car and a two-man crew. The low productivity in study No. 30 was caused by fallen cases, a part-time checker, and damaged lips on slipsheets, which accounted for 10 percent of the labor time. The most effective unloading procedure included two people, the operator of a forklift with a Pull-Pac attachment and a helper who assisted in engaging the lip of the slipsheet. The helper positioned empty pallets for the slipsheet load and checked the quantity of merchandise received.

Figure 12 shows a Pull-Pac attachment on a forklift truck engaging the lip of a slipsheet in a railcar. On removing the slipsheet load from the railcar, a metal back plate is used to facilitate the transfer and positioning of the slipsheet unit load onto a pallet (fig. 13). A back plate or wall is



PN-5074

FIGURE 12.—Engaging a slipsheet load of groceries in a railcar.



PN-5075

FIGURE 13.—Transferring a slipsheet unit load to empty pallet with metal back plate.

recommended to help stabilize the load as it is transferred to a pallet. In addition, a stack of empty pallets should be positioned nearby to reduce the time and labor required to position the pallet needed for slipsheet loads.

The greatest damage occurred with slipsheet loads, caused by load shifting in transit and product damage in unloading. Slipsheet unloading can be improved by (1) using stronger slipsheets, at least 80 points, (2) placing slipsheets so the lip is available for engagement by the Pull-Pac, and (3) securing the load to prevent shifting in transit.

The salvage value of used slipsheets was excluded from the study because only one firm baled them. Manual handstacking of the center section of the railcar was common in slipsheet loads because the Pull-Pac forklift cannot maneuver in a small area. The manual unloading of the center section was a factor in lowering the overall productivity of slipsheet loads. As shown in table 5, slipsheet unloading cost $2[illegible]5 per 1,000 cases and $0.590 per 1,000 pounds.

Shrink Film Wrap Unloading

Studies of shrink film wrap unloading of railcars were limited because of the small number of suppliers using the system. The cost of the film wrap at $1 per unit load was the major factor prohibiting its use in shipping. Shrink film wrap has a definite advantage because it protects the product in shipment, eliminates the need for load-securing devices, and reduces damage. The railcars studied arrived with the product in excellent condition, and unloading was faster than the other methods (app. table 19), although the unit loads had fewer cases than pallet loads. Shrink or shroud wrapped unit loads were especially effective for bagged pet food, charcoal, flour, sugar, fragile items, and small cases.

As shown in table 5, shrink film at $7.06 per 1,000 cases and $0.263 per 1,000 pounds was the lowest cost system of unloading. Unloading productivity was 1,246 cases per man-hour, considerably higher than any other system (app. table 19).

AN EVALUATION OF RAILCAR SHIPPING SYSTEMS

Railcar loading was generally well organized and with a minimum size crew. When railcars were loaded by pallet, slipsheet, or clamp, the forklift operator usually worked alone and checked the loading invoices. The only damage observed occurred prior to loading. Except for handstacked loads, the cost of materials, including platforms, load-securing tape, and dunnage, was the largest part of the total cost—69 percent for pallets and 60 percent for slipsheets.

Railcar unloading was a very labor-intensive operation, and it is vital that unitization or mechanization be increased to control costs. This is difficult because of the wide variety of products, the uncertainty of the number of cars to be unloaded, and the necessity of having crews available to handle the volume on peak receiving days. This explains why the unloading crews were larger than required in many of the studies.

The most effective load-securing devices were film wrap, box-type bumpers, and fiberboard dividers. The taping or tying of the top layer alone did not prevent shifting of the unit loads, which were often wedged together upon arrival at the distribution warehouse.

Several methods can be used to evaluate the cost of various systems for shipping groceries by railcar. One method would be to evaluate the systems on the basis of combined labor productivity, such as cases handled per man-hour, which measures the effective use of labor and equipment. As shown in table 6, productivity of the pallet system was next to the highest, yet it was next to the least costly per 1,000 pounds as shown in table 7, because cases per man-hour productivity do not include such other costs as materials, equipment, dunnage, and damage. It is also possible to evaluate the respective systems on the basis of cost per load, but this method does not take into account the variation in number of cases and weight included in each load.

The cost per 1,000 cases and per 1,000 pounds was determined as the only valid measure of evaluation. With the exception of shrink film wrapped loads, the average case weight in loading and unloading ranged from 30 to 34 pounds; therefore the total cost of shipping and receiving by method of shipment on a case-weight basis should be comparable. Total shipment costs were lowest for shrink film wrap and pallet shipments, with shrink

TABLE 6.—*Labor productivity of 5 systems for loading and unloading railcars with groceries*

System	Loading productivity per man-hour [1]	Unloading productivity per man-hour [2]	Overall per man-hour [3]
	Number of cases	*Number of cases*	*Number of cases*
Manual	407	239	151
Pallet	1,388	900	545
Slipsheet	1,059	573	370
Clamp	1,044	239	195
Shrink film wrap	1,481	1,246	674

[1] Appendix table 17, with shrink film wrap included in studies 45, 54, and 55.
[2] Appendix table 19.
[3] Determined as follows using the manual system as an example: (60 min÷407 cases)+(60 min÷239 cases)=0.3984 min per case or 60 min÷0.3984 min per case=151 cases.

TABLE 7.—*Cost comparison of 6 systems for loading and unloading railcars with groceries*

System	Loading cost [1] per—			Unloading cost per—			Total cost per—		
	1,000 cases	1,000 lb	Load	1,000 cases	1,000 lb	Load	1,000 cases	1,000 lb	Load
Manual	$17.11	$0.532	$32.13	$31.37	$0.867	$48.99	$48.48	$1.399	$81.12
Pallet	17.01	.628	51.26	11.15	.341	26.41	28.16	.969	77.67
Slipsheet	19.77	.676	36.84	21.55	.591	30.21	41.32	1.267	67.05
Clamp on floor	11.78	.500	29.17	31.37	.867	48.99	43.15	1.367	78.16
Clamp on slipsheet	18.24	.775	45.17	21.55	.591	30.21	39.79	1.366	75.38
Shrink film wrap [2]	11.34	.418	34.17	7.06	.263	14.01	18.40	.681	48.18

[1] Includes cost for labor, equipment, materials, and dunnage.
[2] Loading cost includes cost for pallet loading in appendix table 18 minus cost for dunnage, since dunnage is not used in shrink film wrap loading.

film wrap the lowest cost per 1,000 cases and per 1,000 pounds as shown in table 7. There was little variation in the total cost per 1,000 cases of the other systems for loading and unloading.

Several factors can qualify the total cost comparison, including (1) insufficient studies by commodity groups to provide a precise evaluation by method of shipment, because some commodities were not loaded by a particular method of shipping, such as paper, cereal, and bagged items on pallets; (2) the quality of slipsheets used by some suppliers created problems in unloading; and (3) no cost was assigned for the weight of the pallet in either shipping or return of empty pallets. When a firm is not on a pallet exchange program or cannot use the 5–1 pallet return program or has captive railcars, there would be an additional cost for pallet shipments. An alternative on a limited basis is for such suppliers to arrange with the distribution warehouse to purchase the pallets. Each system of unitized shipping can be improved by using better unloading methods and trained crews, particularly at the distribution warehouse.

Freight charges are not provided in the cost comparison because they are not controllable. Rates were obtained for freight charges by rail shipment from Atlanta, Ga., to Miami, Fla., and are shown in table 8 and in appendix table 18 for each study on the basis of charges per 100 pounds and railcar load. The charges for a given distance do not vary for items packed in glass, high density,

or plastic containers, except they are gradually reduced as the weight of product loaded per railcar increases. Heavy bagged items are usually shipped at the same rate whether in 40- or 50-foot railcars because the weight is usually in the 80,000- to 100,000-pound category.

TABLE 8.—*Schedule of rail freight rates by product category from Atlanta, Ga., to Miami, Fla.*

Net load (1,000 lb)	Product category per 100 lb		
	Glass, high density, and plastic	Paper and cereal	Bagged
120 plus	$0.92		
100 to 120	.97		
80 to 100	1.03		$1.00
60 to 80	1.15	$1.20	
50 to 60	1.22	1.37	
40 minimum	1.35		
36 minimum		1.49	

SUPPLIER SHIPMENT BY TRUCK

More groceries are received by truck than by rail at the distribution warehouse. A survey of 129 distribution warehouses supplying retail stores showed the typical warehouse received 60 percent of its groceries by common carrier truck, 30 percent by rail, and 10 percent by backhaul on the return trip to the warehouse on trucks used for delivery to retail stores.[5]

Studies were conducted on four systems of loading trucks at supplier warehouses, including manual, pallet, clamp, and shrink film wrapped cases on pallets. No studies were conducted on slipsheet loading of trucks because of its very limited use.

Railcar arrivals at the distribution warehouse came directly from the supplier or consolidated warehouse, whereas truck arrivals came from five sources: (1) Supplier; (2) consolidated warehouse, typically with several items; (3) trailers on flatcars (piggyback) shipped to a terminal by rail; (4) backhaul with distribution warehouse trucks picking up a load of groceries on a return trip from delivery to a retail store; and (5) less-than-full truckloads from a supplier or terminal warehouse, or a partial load shared with another distribution warehouse (pooled deliveries).

Manual Loading

This was the most labor-intensive loading method because each case was handled individually. In addition, there were delays for the drivers as they waited for the merchandise to be brought to them for loading or for removal of empty pallets and also delays for the forklift operator as he waited for the driver to empty a pallet. This accounts for higher labor cost than the other loading systems as shown in table 9. Manual loading was the highest labor cost system, totaling $16.90 per 1,000 cases or $0.556 per 1,000 pounds.

Studies were conducted in which the truck trailer was partially loaded by clamp or pallet and the remainder of the load was handstacked as shown in figure 14. This resulted in lower loading cost than when the entire load was handstacked. Such studies were not included in order to obtain a uniform comparison of truck loading systems.

Costs for manual loading can be reduced with better coordination between the forklift operator

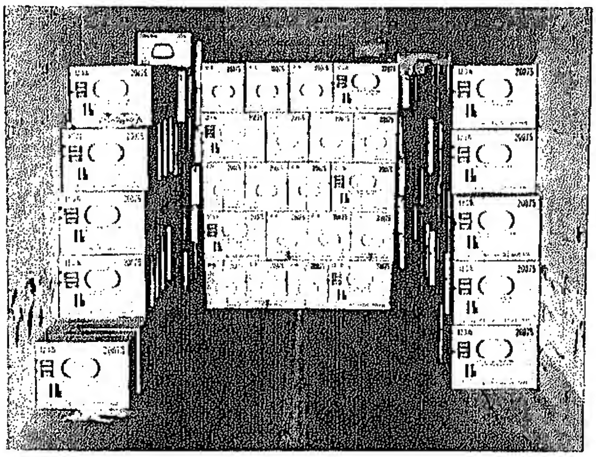
[5] BOUMA, J. C. TRUCK UNLOADING OF MANUFACTURER SHIPMENTS AT GROCERY DISTRIBUTION WAREHOUSES. U.S. Dept. Agr., ARS-NE-68, 23 pp. 1976.

TABLE 9.—*Cost comparison of 4 systems for loading trucks with groceries* [1]

Load size and cost element	Loading system			
	Manual	Pallet	Clamp	Shrink film wrap
Load size:				
Cases__________number __	1, 238	1, 750	1, 167	2, 027
Pounds__________do____	37, 600	41, 100	34, 600	38, 700
Cost element:				
Labor:				
1,000 cases______dollars __	13. 57	1. 81	2. 77	1. 56
1,000 lb__________do____	. 446	. 077	. 094	. 082
Equipment:				
1,000 cases________do____	3. 33	. 59	1. 17	. 44
1,000 lb__________do____	. 110	. 025	. 039	. 023
Materials: [2]				
1,000 cases________do____		4. 77	____________	3. 81
1,000 lb__________do____		. 203	____________	. 200
Dunnage: [3]				
1,000 cases________do____		. 50	. 63	6. 58
1,000 lb__________do____		. 022	. 021	. 345
Total:				
1,000 cases______do____	16. 90	7. 67	4. 57	12. 39
1,000 lb_________do____	. 556	. 327	. 154	. 650

[1] For detailed information on each load, see appendix tables 21 and 22.
[2] Includes cost for unit load platform.
[3] Includes shroud film wrap and tape.

and the loader. In truck shipments a wide variety of items was in each load, especially at consolidated warehouses, and loaders appeared to be excessively concerned about leveling the load and weight distribution.

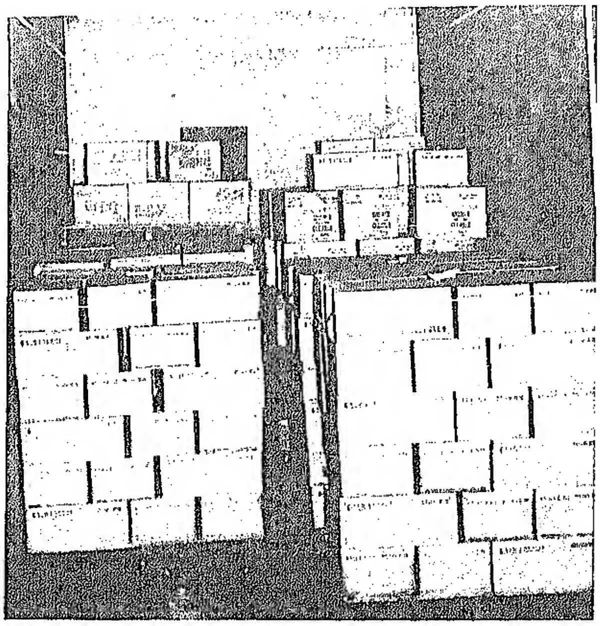


PN-5076

FIGURE 14.—Center of trailer loaded by clamp truck and merchandise handstacked on each side.

Pallet Loading

Loading merchandise on pallets was the simplest system. One forklift operator would transport one or two loaded pallets into the trailer. The product on pallets was sometimes secured with tape or string. Typically, dividers were not used. Occasionally in order to maximize use of cubic space, every other pallet was cross loaded, i.e., the 48-inch side rather than the 40-inch side faced the rear of the trailer. With a 42-foot truck, 20 pallets can be placed on the floor when it is loaded with the 40-inch face, and by cross loading, 22 pallets can be placed on the floor. Since most of the items shipped in unit loads on pallets were heavy, use of cubic space was not a problem. Frequently the items were shipped only one pallet high; however, unit loads on pallets can be stacked two high in trailers (fig. 15).



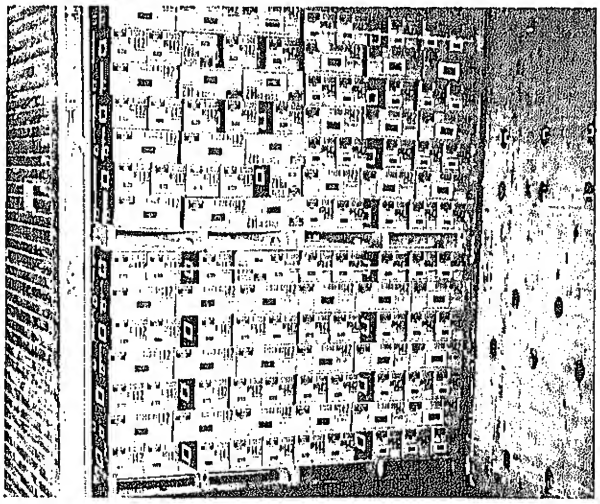


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FIGURE 15.—*Above*, trailer with unit loads on pallets placed one high; *below*, fully loaded trailer with unit loads on pallets stacked two high.

As shown in table 9, when the weight of the pallet is not included in the cost of loading, this system costs next to the lowest. The cost of the pallet, replacement, and depreciation accounted for 62 percent of the cost of pallet loading.

Clamp Loading

Loading with a forklift truck having a clamp attachment was observed in several supplier plants. In general, clamp loading was used for light bulky items, such as paper and cereal products. It is an effective loading system if the load is to be manually unloaded or if maximum utilization of trailer space is desired. The system allows the supplier to utilize palletless storage and handling and also permits loading unitized products with dimensions larger than the standard 48 by 40 inches. It is the lowest cost loading system at $4.57 per 1,000 cases and $0.154 per 1,000 pounds (table 9). This low cost is offset by the higher cost for manual unloading, which is required at most distribution warehouses because they do not have forklift trucks with clamp attachments. Also, the space needed between unit loads to allow clamp unloading would be an expensive cubic space loss in the trailer, particularly for lightweight products.

Shrink Film Wrap Loading

Shrink film wrap is particularly adaptable for loading items in tray pack cases and for wrapping unit loads of items (shroud wrap), such as paper bags containing charcoal, pet food, and sugar. Shrink wrap or shroud wrap loading was next to the most expensive trailer loading system (table 9). The cost of labor and equipment was lower than that of the other systems, but the expense of pallets or slipsheets and the shroud film wrap increased the cost of this loading system.

DISTRIBUTION WAREHOUSE RECEIVING BY TRUCK

Scheduling receiving crews to handle the varying volume of incoming merchandise by truck is difficult unless appointments are made. With appointments, the carrier notifies the warehouse, receives a time to deliver the merchandise, and is assured of dock space for unloading if the appointment is met.

In a recent survey,[6] only 42 percent of the distribution warehouses used an appointment system. Other factors affecting productivity in truck unloading have been evaluated.[6] They include (1) whether or not the load was unitized, (2) avail-

[6] See footnote 5, p. 17.

ability of temporary storage on the dock for merchandise during unloading, (3) availability of proper materials-handling equipment including pallets, and (4) availability of dock personnel to check the merchandise.

Different unloading procedures were observed among the warehouses where studies were conducted. At some warehouses, carrier truck drivers were provided pallets and jacks to unload the truck and place the loaded pallet on the dock, and at other warehouses the driver stacked the merchandise on pallets and warehouse personnel moved the loaded pallet out of the truck. In general, the latter method resulted in higher costs to the individual warehouse because it paid the personnel for transporting groceries out of the truck. Also, more delays occurred in unloading for the driver when the forklift operator moved the groceries to the dock.

Effectiveness of Scheduling Warehouse Truck Receipts

A study was conducted at four warehouses, each having a different procedure for scheduling grocery truck receipts. The procedures studied included (1) all trucks scheduled as to arrival time—the appointment system, (2) only truck receipts scheduled at dock opening time, (3) truck receipts not scheduled, and (4) truck receipts not scheduled except priority given to unitized loads.

The study was conducted between 5 a.m. and noon on peak receiving days, typically Monday through Wednesday. The following information was recorded for each of the incoming trailers: (1) Arrival time at the warehouse gate, (2) elapsed time between arrival and parking at the grocery receiving door, (3) time between parking and beginning to unload, (4) time unloading was completed, and (5) cause of any unusual waiting time.

It was determined that a scheduling program with all appointments made for the time when the dock opened would not reduce waiting time for the driver and tractor-trailer. It could in fact create more dock congestion and require additional dock personnel and equipment. A central check-in station for drivers where all purchase orders were well organized would reduce the waiting time from arrival at the dock to parking at the door. Equally important to reduction in waiting time through an appointment system are such factors as (1) having sufficient receiving doors to handle the peak receiving volume, (2) flexibility in balancing the dock personnel workload through extensive backhauls, and (3) rapid clearing of the dock into permanent storage to provide more space and eliminate congestion at the receiving doors.

It was also determined that the effectiveness of an appointment system alone could not be measured based on data obtained at the four warehouses. Because the number of dock receiving doors, the dock arrangement, and crew organization varied from one warehouse to another, it was not possible to clearly isolate the effect of the appointment system on truck waiting time.

To measure the effectiveness of the appointment system, the best procedure was a "before and after" study in one firm. One of the cooperating firms was planning to convert to the appointment system. Studies were made of 94 grocery receivings at this firm prior to installing the appointment system. When the system was operating effectively, studies were conducted on 84 receivings.

During observation of the receivings and analysis of the data, the waiting time for supplier trucks and the firm's backhaul trucks was significantly different. The backhaul trucks were parked at the receiving door for up to 3 hours before unloading. Waiting time for the two types of receivings—supplier and backhaul trucks—needed to be analyzed separately. This separation had no effect on evaluating the appointment system, since the total waiting time of the backhaul trucks was almost identical in the "before and after" study (table 10). The observers were unable to determine whether the waiting time for the backhaul trailers was due to lack of equipment and personnel for unloading or due to balancing the receiving workload.

As shown in table 10, the appointment system was effective in reducing the waiting time for supplier trucks, amounting to 6.20 minutes, or 31 percent. No basic change occurred in the management or operation of the truck receiving dock after installation of the appointment system in the firm studied. The total cost of driver and tractor-trailer waiting time for supplier trucks was reduced from \$3.14 to \$2.17 per receiving (table 11). The \$0.97 reduction per receiving is significant, since many

large warehouses receive merchandise from 100 trucks daily.

TABLE 11.—*Costs of driver and tractor-trailer waiting time per receiving before and after installing appointment system in 1 firm*

Cost element	Before appointment system	After appointment system	Savings
Labor [1]	$2.42	$1.67	$0.75
Equipment [2]	.72	.50	.22
Total	3.14	2.17	.97

[1] Based on driver cost of $7.20 per hour.

[2] For details on computing depreciation cost of $2.16 per hour for tractor and trailer, see appendix table 23.

Manual Unloading

Manual unloading of trucks was the least productive based on cases per man-hour, because every case had to be handled individually. Overall productivity averaged only 253 cases per man-hour for the 11 loads in this study (app. table 24). The rate at which trucks were unloaded manually was not only dependent on the facilities and equipment but also on the method of driver payment. When drivers are paid by the load for delivery of product, they are usually anxious to unload as soon as possible because their time and equipment are valuable to them. In one instance, not included in this study, the driver and helper were paid an hourly rate and took 7½ hours or 15 man-hours to unload 1,000 cases. In this instance, unloading equipment at the dock receiving door and the receiving personnel were required for a full day. Another major problem in manual unloading is a delay for the unloader in waiting for a dock forklift to remove the filled pallet and bring an empty pallet. This delay ranged from 9 to 48 percent of the unloader's time and averaged 23 percent.

Manual unloading was the highest total cost system as shown in table 12, amounting to $33.50 per 1,000 cases or $1.002 per 1,000 pounds. If distribution warehouses could eliminate manual unloading, they could reduce the number of receiving doors and perhaps the time required for the dock to be open.

TABLE 10.—*Truck waiting time before and after using warehouse receiving appointment system for supplier and backhaul trucks in 1 firm*

Type of receiving	Before using appointment system				After using appointment system				Reduction in waiting time
	Studies	Time between arrival and parking	Time between parking and beginning to unload	Total time	Studies	Time between arrival and parking	Time between parking and beginning to unload	Total time	
	Number	*Minutes*	*Minutes*	*Minutes*	*Number*	*Minutes*	*Minutes*	*Minutes*	*Minutes*
Supplier trucks	55	13.98	6.16	20.14	55	8.22	5.72	13.94	6.20
Backhaul trucks	39	7.15	41.10	48.25	29	17.55	30.51	48.06	.19

TABLE 12.—*Cost comparison of 4 systems for unloading groceries from trucks* [1]

Load size and cost element	Unloading system			
	Manual	Pallet	Slipsheet	Shrink film wrap
Load size:				
Cases...............number..	1, 056	1, 100	1, 300	1, 162
Pounds...............do....	35, 300	34, 400	40, 500	35, 100
Cost element:				
Labor:				
1,000 cases........dollars..	25. 02	2. 87	9. 07	2. 35
1,000 lb............do....	. 749	. 092	. 291	. 078
Equipment:				
1,000 cases.........do....	4. 35	. 62	1. 55	. 61
1,000 lb............do....	. 130	. 019	. 050	. 020
Damage:				
1,000 cases.........do....	4. 13	5. 03	3. 08	------------
1,000 lb............do....	. 123	. 161	. 099	------------
Total:				
1,000 cases........do....	33. 50	8. 52	13. 70	2. 96
1,000 lb..........do....	1. 002	. 272	. 440	. 098

[1] For detailed information on each load, see appendix tables 24 and 25.

Pallet Unloading

Productivity in unloading palletized grocery trailers was more than 9 times greater than manual unloading—2,364 compared with 253 cases per man-hour as shown in appendix table 24. A major factor contributing to productivity in pallet unloading was the negligible delays for driver and dock personnel. One impediment to greater unloading productivity was the need to straighten the pallet loads of product that shifted in transit before unit loads could be removed from the truck (fig. 16). As shown in appendix table 25, only 23 percent (3 of 13 loads) of the palletized loads studied had the upper layers tied together with tape or string. This lack of support contributed to the high cost of damage, which was 59 percent of the unloading cost as shown in table 12. Pallet unloading was the second lowest cost system studied because of the high cost of damage—$8.52 per 1,000 cases or $0.272 per 1,000 pounds. This damage can be greatly reduced by using tape or string to hold the unit load together. Another factor, which was not included in this study but did incur added expense in receiving palletized shipment, was the need to repalletize several lay-

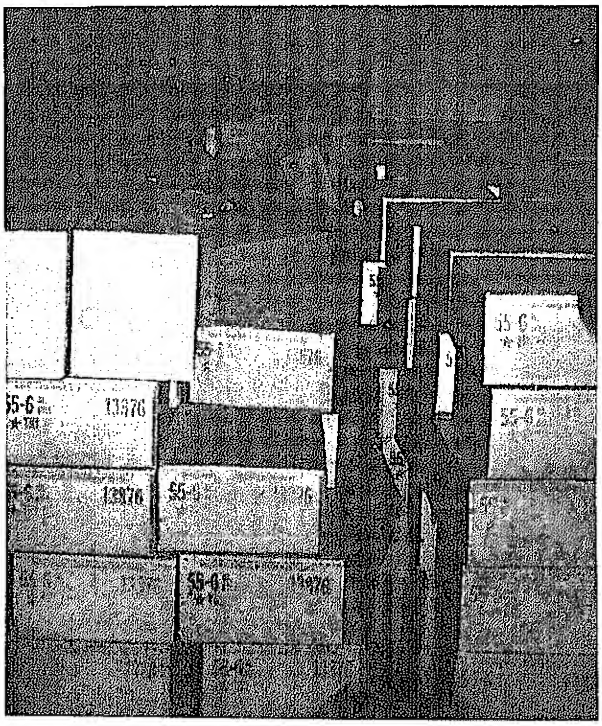

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FIGURE 16.—Palletized load of product that shifted during transit.

ers of product in order to fit the palletized loads in storage racks as shown in figure 17.

Slipsheet Unloading

Slipsheet unloading is seldom used for trucks. To evaluate this system it was necessary to request a forklift truck with a Pull-Pac attachment from the rail receiving dock. The available equipment at two distribution warehouses was not satisfactory because the mast on the forklift was too high to enter the trailer. As indicated in a previous study, the greatest impediment to unloading slipsheet loaded trucks was the lack of proper equipment at distribution warehouses.[7] With proper communication between buyer, supplier, carrier, and warehouse operator and with proper forklift equipment at the distribution warehouse, this system has good potential. Many suppliers and managers of distribution warehouses indicated during this study that the slipsheet system has a greater potential than is being experienced.

The unloading of only two trailers was time-studied. However, the labor cost for slipsheet unloading was only one-third that of manual unloading, but it was approximately three times greater

[7] See footnote 5, p. 17.

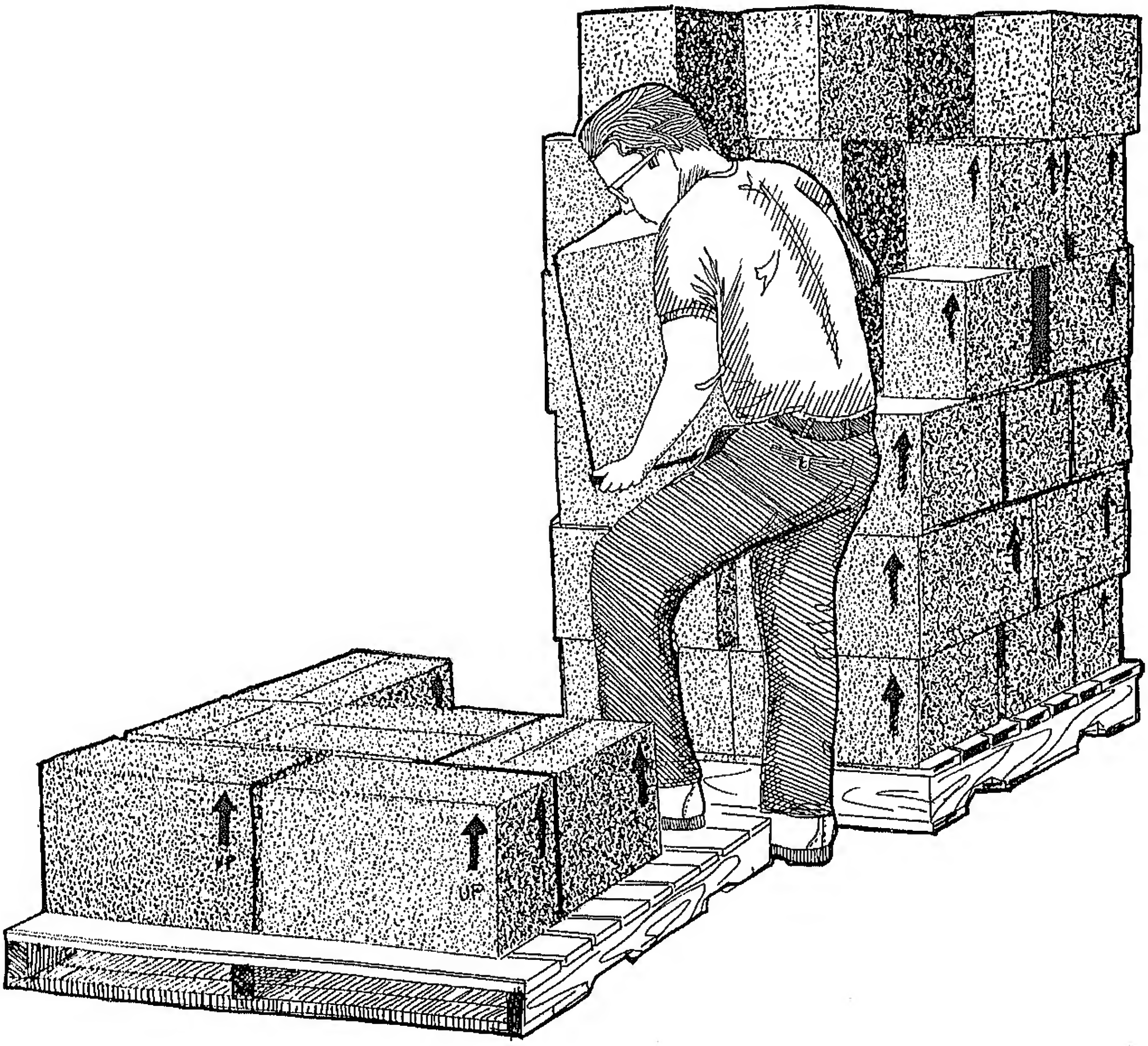

FIGURE 17.—Repalletizing several layers of product in order to fit pallet loads in storage racks.

than pallet unloading (table 12). The damage during unloading was caused by the engaging of, or chiseling under, the slipsheet and could have been reduced with a heavier gage slipsheet. Only two studies did not seem to provide a complete evaluation of slipsheet unloading potential. With more experienced warehousemen for unloading, the productivity and cost will be only slightly higher than for unloading on pallets. As shown in table 12, the cost for slipsheet unloading was $13.70 per 1,000 cases or $0.440 per 1,000 pounds.

Shrink Film Wrap Unloading

This was the most efficient and lowest cost system of unloading trailers. The loads were well secured, the forklift operator worked alone and could easily check the load because only one item was on each unit load, and no damage occurred in the seven loads studied. With shroud film wrapped loads, the disposal of the film wrap at the warehouse must be considered.

When individual tray pack cases were shrink film wrapped, they held together as well as shroud film wrapped unit loads and did not require the film removal and disposal at the warehouse. As shown in table 12, the cost of shrink film wrap unloading was $2.96 per 1,000 cases or $0.098 per 1,000 pounds.

AN EVALUATION OF TRUCK SHIPPING SYSTEMS

Any system using unitized loading or unloading is less expensive than manual loading and unloading for truck shipment from supplier to distributor. As shown in table 13, manual loading and unloading cost $50.40 per 1,000 cases. Three unitized systems had costs less than half the cost of manual loading and unloading. They included shrink film wrap at $15.35, pallet without freight at $16.19, and clamp loading on slipsheet at $25.14 per 1,000 cases.

The cost of transporting the pallet as well as the pallet return is the important consideration when using palletized truck shipments. If a palletized return shipment is obtained at the point of destination, the problems of returning empty pallets are eliminated. However, long-haul common carrier trucks have a weight objective and are typically paid for their load on a weight basis. They are therefore reluctant to haul pallets without recognition of the weight and return problems.

Assuming a freight rate of $1.72 per hundred pounds, the weight of the pallets would cost $27.52 for 20 pallets in a load (20 pallets at 80 pounds each). The cost for loading, including labor, equipment, dunnage, and pallets, is $13.43 plus transportation cost for 20 pallets of $27.52 would equal $40.95 for pallet loading with freight (table 13). Without freight charges, pallet handling was the lowest cost system for loading and unloading.

With the exception of the pallet with freight system, the shrink film wrap shipment had the highest loading and lowest unloading cost. If the warehouse operator and retailers would share the cost of the film wrap to compensate for savings in unloading and retail shelf stocking, this would probably prove to be the system held in greater favor by suppliers and would probably be the lowest total cost system from supplier to retail store shelf.

Clamp loading was the lowest cost system and could be a low cost receiving method, particularly for heavy dense products, if dunnage is used to keep the unit loads separated during transit and if clamp unloading equipment is available at the distribution warehouse. The problems associated with clamp unloading at the distribution warehouse include (1) availability of equipment for unloading, (2) height of the trailer door, (3) ability of the trailer floor to support the heavier clamp equipment, and (4) variety of points of origin for truck shipments. Similar conditions apply to slipsheet loads plus the need for stronger sheets and consideration of the cost of slipsheets.

Freight charges are much greater than handling costs for both rail and truck shipments (app. tables 18 and 22). The rates per hundredweight for over-the-road trailers and trailers on flatcars (rail piggyback) are shown in table 14. They do not reflect less-than-truck-lot or backhaul shipments. Since the point of origin for the comparative schedule, Atlanta, Ga., was not the source for several commodities, other points of origin in the general area of Atlanta were used and the rate was adjusted for the 677-mile distance from Atlanta to Miami, Fla.

TABLE 13.—*Cost comparison of 6 systems for shipping groceries by truck from supplier to distribution warehouse*

System	Loading cost [1] per—			Unloading cost [2] per—			Total cost per—		
	1,000 cases	1,000 lb	Load	1,000 cases	1,000 lb	Load	1,000 cases	1,000 lb	Load
Manual	$16. 90	$0. 556	$20. 92	$33. 50	$1. 002	$35. 38	$50. 40	$1. 558	$56. 30
Pallet without freight	7. 67	. 327	13. 43	8. 52	. 272	9. 38	16. 19	. 599	22. 81
Pallet with freight [3]	23. 38	. 995	40. 95	8. 52	. 272	9. 38	31. 90	1. 267	50. 33
Clamp – on floor	4. 57	. 154	5. 34	33. 50	1. 002	35. 38	38. 07	1. 156	40. 72
Clamp – on slipsheet [4]	11. 44	. 386	13. 34	13. 70	. 440	17. 80	25. 14	. 826	31. 14
Shrink film wrap	12. 39	. 650	25. 12	2. 96	. 098	3. 45	15. 35	. 748	28. 57

[1] Includes costs for labor, equipment, unit load platform, film wrap, and tape.
[2] Includes costs for labor, equipment, and damaged cases.
[3] Includes cost of freight for pallets at $1.72 per hundredweight, 80 lb per pallet, 20 pallets, and average load of 1,750 cases.
[4] Includes cost of slipsheet at $0.40 each.

TABLE 14.—*Schedule of truck freight rates per hundredweight by commodity from Atlanta, Ga., to Miami, Fla.*

Minimum load (pounds)	Glass, high density, and plastic	Paper	Cereal	Bagged item	Sugar
30,000 [1]	$1. 96	$2. 50	$3. 46	$1. 96	
42,000 [1]					$0. 87
38,500 [2]	1. 00	1. 00	1. 00	1. 00	1. 00
Weighted average [3]	1. 72	2. 12	2. 85	1. 72	. 90

[1] Rate for over-the-road trailers.
[2] Rate for trailer on flatcar (piggyback), including delivery at pickup at both supplier and distribution warehouse.
[3] Based on 75 pct of shipments on over-the-road trailers and 25 pct on trailer on flatcar.

ADDITIONAL FACTORS AFFECTING EFFICIENCY OF HANDLING GROCERIES FROM SUPPLIER TO DISTRIBUTION WAREHOUSE

This study was conducted in warehouses that used efficient work methods. In one instance, not included in this analysis, a handstacked rail load cost 3½ times as much in labor to unload as the average because of unsatisfactory methods and a larger crew than was necessary. In addition to crew sizes and methods as well as unitization and manual methods for loading and unloading, other factors affecting the cost of moving groceries from the supplier to the food distribution warehouse include (1) quantities of product ordered and received, (2) need to repalletize because layers of product have to be removed to fit into storage racks or because more than one item is on the pallet, and (3) use of consolidated warehouses.

Ordering and Receiving Quantities

The distribution warehouse is designed to store each item based on movement, with an allowance for reorder time and with a minimum of out-of-stock condition. Excess inventory, although often essential for special sale promotions, creates additional warehouse handling and ties up capital. The racking in the warehouse varies to accommodate differences in item movement—from floor stacks and drive-in or drive-through racks to standard pallet racking, where as many as nine 40- by 32-inch pallets are slotted for order selection. In some warehouses the low volume items are stored and selected from multilevel racks, which reach from floor to ceiling, with special machines used for order selection.

The tie and height for each pallet load should appear on the warehouse inventory printout and in the buyer's guide. The buyer, knowing the anticipated movement of each item and the tie and height of the pallet, should order in even pallet quantities. If this exceeds the normal movement, then he should order in layer quantities. For example, if a pallet capacity is 5 layers high and 15 cases per layer, then he should order either in units of 75 or at least 15. This will eliminate the need for removing layers from unit loads, which often occurs. If the item is to be stored on the 40- by 32-inch pallet, the buyer should order in the proper tie and height quantity even though the cases have to be manually placed on small pallets. It is important that buyers change from buying in even quantities, such as 50, 100, and 200, and order in operationally efficient pallet or layer quantities. They should also seek guidelines from the suppliers or their sales representatives to identify unit load and truckload quantities that are most economical for shipment.

In a study of nine unitized loads, an average of 15 percent of the cases to be unloaded had to be removed from the top of the pallet load (delayered) and placed on another pallet (repalletized) in order to enable the unit loads to fit in pallet racks. The standard time for unloading without delayering was 50.8 man-minutes per 1,000 cases. It was 62 percent greater or 82.2 man-minutes per 1,000 cases when cases had to be delayered and repalletized. The increased labor cost at $6 per hour amounted to $3.14 per 1,000 cases. Besides the labor, increased costs were also incurred for the additional time that unloading equipment was used and the dock space was occupied.

Some of this removal of layers could be eliminated by improved loading procedures. In one railcar, the unit load for a single item varied from three to six layers high, whereas the correct number of layers for storage was four. In another railcar with products loaded on slipsheets, the center section was manually loaded only one case high, whereas some of the slipsheet loads behind the bulkhead doors had one too many layers.

In other shipments, several pallet loads in the car had more than one item on them, whereas the center section of the car was manually stacked with one of the same items. A solution to the mixing of several items on a unit load is to manually stack them in the center section or to reserve certain unit load platforms for loads with more than one item.

During this study, suppliers indicated that only 10 percent of their largest volume customers specify the tie and height for unit load shipments and that 43 percent of the items ordered are not even unit loads. Since the supplier usually does not know the tie and height requirements for each distribution warehouse, he will use the standard unit load that comes off the automatic palletizer

and will try to achieve full utilization of the carrier vehicle. There appears to be an increasing awareness of the needs in the distribution warehouse on the part of company buyers. With improved communication between the supplier and distribution warehouse buyer, more products can be purchased in unit load quantities in the required tie and height.

Repalletizing to Smaller Pallets

Some effort has been made by distribution warehouses to encourage the Grocery Pallet Council (GPC) to establish a second size of standard pallet for grocery shipping. This pressure has come from distribution warehouses using both the 48- by 40-inch and the 40- by 32-inch pallets for product storage.

As shown in table 15, firms A and B with dry grocery product annual sales of approximately 4.3 and 20 million cases, respectively, had 41 and 46 percent of the items stored on 40- by 32-inch pallets. However, the case volume movement on 48- by 40-inch pallets in firms A and B was 80 and 90 percent, respectively. The significant amount—41 and 46 percent of the items (typically low volume items)—must be either repalletized from 48- by 40-inch unit load receipts or loaded directly on the 40- by 32-inch pallet from manually stacked loads.

In firm A with 1,250 items stored on small pallets in 208 pallet rack bays with 6 pallets per bay, an additional 104 pallet rack storage bays would be required if all items were placed on 48- by 40-inch pallets with 4 pallets per rack bay. Similarly, in firm B, with 3,082 items stored on small pallets, an additional 256 pallet rack bays would be required if large pallets were used. Since each pallet rack bay requires 86 square feet of floorspace, including aisles, an additional 8,944 square feet of warehouse space would be needed in firm A and 22,016 square feet in firm B. Assuming an annual cost for the needed space and pallet racks of $2.50 per square foot, the added annual cost would be $22,360 in firm A and $55,040 in firm B. Based on an annual volume of 860,000 cases of slow moving items in firm A and 2 million cases in firm B, being placed on large instead of small pallets, the added cost for space and racks would total $26 per 1,000 cases in firm A and $27.52 in

TABLE 15.—*Additional cost for space and pallet racks in 2 firms using 48- by 40-inch pallets for storage and selection compared with using 40- by 32-inch pallets*

Element	Firm A	Firm B
Cases shipped annually ________ number __	4, 300, 000	20, 000, 000
Slow moving cases shipped annually ________ do ____	860, 000	2, 000, 000
Items in inventory ________ do ____	3, 048	6, 700
Slow moving items in inventory ________ do ____	1, 250	3, 082
Pallet rack bays required with large pallets [1] __ do ____	312	770
Pallet rack bays required with small pallets [2] __ do ____	208	514
Additional rack bays with large pallets ________ do ____	104	256
Additional space required with large pallets [3] square feet __	8, 944	22, 016
Annual cost for added space and racks with large pallets [4] ________ dollars __	22, 360	55, 040
Added cost per 1,000 cases with large pallets [5] __ do ____	26	27. 52

[1] Based on four 48- by 40-in pallets per rack bay for order selection.
[2] Based on six 40- by 32-in pallets per rack bay for order selection.
[3] Based on 86 ft^2 of floorspace per pallet rack bay, including aisles.
[4] Based on annual warehouse space and pallet rack cost of $2.50 per square foot.
[5] Annual added space and rack cost divided by thousands of cases of slow moving items shipped ($22,360÷860; $55,040÷2,000).

firm B. This cost does not take into account the increased cost for order assembly that would be required with additional travel distance.

In a study of four unitized railcar loads, an average of 26 percent of the cases to be unloaded had to be repalletized on 40- by 32-inch pallets. The standard unloading time was 111.1 man-minutes per 1,000 cases without repalletizing and 169.3 man-minutes per 1,000 cases with repalletizing. With labor cost at $6 per hour, the added cost for repalletizing amounted to $6 per 1,000 cases. However, table 15 shows that increased costs for space and racks in order to handle the same volume on 48- by 40-inch pallets as on 40- by 32-inch pallets amount to $26 and $27.52 per 1,000 cases in firms A and B. Accordingly there is a savings of more than $20 per 1,000 cases when the present 2 sizes of pallets are used.

It would probably be advantageous to warehouses with many slow moving items if a smaller pallet, such as the 40- by 32-inch, were used for shipping unitized grocery products to eliminate much of the manual unloading. However, such advantages must be weighed against other factors. For example, if such a system is implemented, suppliers would need to constantly reset the automatic palletizer for the two sizes of unit loads and would need to carry separate inventories of product by unit load size, as well as separate unit load platform inventories, such as pallets and slipsheets. Problems now exist in effectively utilizing the capacity of railcars and trailers with 48- by 40-inch unit loads, and improved utilization cannot be visualized with a smaller unit load given existing vehicle dimension limitations. There are problems in the present pallet exchange program with only one pallet size, and a second pallet size would compound the problem. Based on these limitations, the dry grocery distribution system appears to have too many built-in limitations for the introduction of a second size of standard pallet. However, it appears advisable that use of the 40- by 32-inch pallet for storage at distribution warehouses be continued because the cost of converting to the 48- by 40-inch pallet is greater than the necessary repalletizing costs.

Consolidated Service Warehouses

A smaller quantity of merchandise is delivered to the warehouse in less than truckload (LTL) quantities than is ordered in LTL quantities.[8]

One reason for this is the number of consolidated warehouses that store products from several suppliers and combine orders going to a particular distribution warehouse in full common carrier loads. Theoretically, savings are accomplished through use of transportation rates for full common carrier loads as opposed to rates for less-than-full carrier loads. The consolidated warehouses do not take title to the product in storage and are classified for transportation rate purposes as in-transit warehouses.

One of the first and largest consolidated service warehouses was included in the study of suppliers. Although we cannot generalize from only one plant, several observations can be given. The consolidated warehouse supplied distribution warehouses with products from approximately 30 manufacturers and thus permitted the manufacturer to ship unit loads or complete railcars of a single item. This could be a factor in the low cost of loading railcars in some of the supplier plants we studied. This intermediate warehouse does not completely resolve the problem of low cost food distribution because another link is added to the distribution chain where products must be received, stored, and selected. The time for labor to unload railcars and place in storage was not studied, but the labor for order assembly and loading of two railcars was studied but not included in the loading standard. Table 16 shows the results of this study.

More than twice as much time was required for order assembly than for loading. When the order selector used a forklift truck with clamp to remove one or more layers from a pallet and then proceeded to remove additional layers from other pallets to build a single unit load, the time for order assembly increased. The mixing of items on a unit load also resulted in the need for more unloading time at the distribution warehouse because each item would need to be placed on separate pallets. All truck shipments observed were hand-stacked and resulted in loss of efficiency in both loading and unloading.

Lower freight costs are just one of the advantages of the consolidated warehouse concept for LTL supplier shipments. The consolidated ware-

[8] See footnote 5, p. 17.

TABLE 16.—*Labor required for order assembly and loading railcars at a consolidated warehouse*

Load	Cases	Order assembly productivity		Loading productivity	
	Number	*Man-hours*	*Cases per man-hour*	*Man-hours*	*Cases per man-hour*
1	2, 112	2. 13	992	1. 46	1, 447
2	3, 562	4. 03	884	1. 21	2, 944
Weighted average	2, 837	3. 08	921	1. 34	2, 117

house also has pallet exchange programs with the carriers to lower freight costs. Since the product from the manufacturer was closer to the distribution warehouse, the reorder period was reduced and should allow for better inventory control at the distribution warehouse and retail store. It should not be assumed that inventories in the total system are reduced because of this fact alone. Many improvements in warehouse layout and physical handling methods could be incorporated at the consolidated warehouse to reduce the cost of operation.

An alternative to the consolidated warehouse is for the manufacturer to consolidate on a trailer the unit loads of a limited number of items that are designated for one or more distribution warehouses in a given metropolitan area. This would allow the distribution warehouse to take advantage of low full-trailer rates and unit load unloading. It would also allow the distribution warehouse to order items perhaps once a week rather than every 2 or 3 weeks and result in less inventory. This would require substituting stopover charges for LTL rates and increase unloading efficiency.

APPENDIX

TABLE 17.—*Labor and materials costs of 4 systems for loading railcars with groceries*

Load	Product category	Cases	Weight	Unit load size	Crew size	Labor required per— Case	Labor required per— Load	Labor cost per load [1]	Man-hour productivity	Materials Amount	Materials Cost [2]	Total labor and materials cost per load
		Number	*Pounds*	*Number of cases*	*Number*	*Man-minutes*	*Man-minutes*	*Dollars*	*Number of cases*	*Number*	*Dollars*	*Dollars*
	MANUAL LOADING											
33	Glass	1, 952	50, 300		3	0. 1707	333. 2	33. 32	352			33. 32
34	High density	2, 392	81, 300		3	. 1566	374. 6	37. 46	382			27. 46
34A	do	1, 416	50, 500		1	. 1003	142. 0	14. 20	598			14. 20
35	Plastic	3, 718	81, 800		3	. 1307	485. 6	48. 56	459			48. 56
36	do	2, 860	97, 200		3	. 1374	393. 0	39. 30	437			39. 30
37	Paper/cereal	1, 315	39, 000		3	. 1490	195. 9	19. 59	403			19. 59
38	do	1, 085	33, 800		1	. 1932	209. 6	20. 96	311			20. 96
38A	Bagged	1, 157	58, 900		1	. 1579	182. 7	18. 27	380			18. 27
39	do	1, 008	50, 400		1	. 1733	174. 7	17. 47	343			17. 47
	Average	1, 878	60, 400		2	. 1521	276. 8	27. 68	407			27. 68
	PALLET LOADING											
24	Glass	2, 112	76, 100	71	1	. 0531	112. 1	11. 21	1, 130	25	10. 00	21. 21
25	do	3, 562	108, 300	87	1	. 0399	142. 1	14. 21	1, 504	25	10. 00	24. 21
26	High density	2, 572	102, 800	70	1	. 0516	132. 7	13. 27	1, 163	58	23. 20	36. 47
27	do	6, 368	129, 800	122	1	. 0225	143. 3	14. 33	2, 667	50	20. 00	34. 33
28	Paper/cereal	6, 113	122, 300	118	1	. 0293	179. 1	17. 91	2, 048	50	20. 00	37. 91
29	do	1, 199	38, 100	27	1	. 0662	79. 4	7. 94	906	40	16. 00	23. 94
30	do	1, 181	36, 600	26	1	. 0520	61. 4	6. 14	1, 154	40	16. 00	22. 14
31	do	1, 707	42, 700	41	1	. 0623	106. 3	10. 63	963	58	23. 20	33. 83
32	Plastic	2, 566	79, 600	69	1	. 0482	118. 5	11. 85	1, 245	58	23. 20	35. 05
32A	do	2, 740	79, 900	48	1	. 0543	148. 8	14. 88	1, 104	58	23. 20	38. 08
	Average	3, 012	81, 600	68	1	. 0472	122. 4	12. 24	1, 388	46	18. 48	30. 72

				SLIPSHEET LOADING								
40	Glass	1,416	50,000	48	2	.0460	65.1	6.51	1,304	28	11.20	17.71
41	High density	2,780	94,500	50	1	.0596	165.7	16.57	1,007	40	16.00	32.57
42	do	2,540	106,700	44	1	.0719	182.6	18.26	834	40	16.00	34.26
46	Plastic	3,380	74,400	65	1	.0482	162.9	16.29	1,245	40	16.00	32.29
47	do	2,780	61,600	55	1	.0506	140.1	14.01	1,186	18	7.20	21.21
43	Paper/cereal	986	30,800	16	1	.1412	139.2	13.92	425	72	28.80	42.72
44	do	550	22,200	30	1	.0761	41.9	4.19	788	18	7.20	11.39
45	do	3,600	44,000	50	1	.0307	110.5	11.05	1,954	40	16.00	27.05
46A	do	550	22,200	30	1	.0880	48.4	4.84	682	40	16.00	20.84
47A	Bagged	960	48,000	20	1	.0579	55.6	5.56	1,200	40	8.80	14.36
47B	do	950	45,000	20	1	.0526	50.0	5.00	1,026	40	8.80	13.80
	Average	1,863	54,500	39	1.1	.0657	105.6	10.56	1,059	35	13.82	24.38
				CLAMP LOADING								
48	High density	2,780	94,500	50	1	.0570	158.5	15.85	1,053	---	---	15.85
49	do	2,540	106,700	44	1	.0693	176.0	17.60	866	---	---	17.60
50	Plastic	3,380	74,400	50	1	.0453	153.1	15.31	1,324	---	---	15.31
51	do	2,780	61,600	50	1	.0481	133.7	13.37	1,247	---	---	13.37
52	Paper/cereal	550	22,200	30	1	.0838	46.1	4.61	716	---	---	4.61
53	do	986	30,800	16	1	.0915	90.2	9.02	656	---	---	9.02
54	do	3,600	40,800	50	1	.0401	144.3	14.43	1,496	---	---	14.43
55	do	3,195	35,700	50	1	.0604	193.0	19.30	993	---	---	19.30
	Average	2,476	58,300	42	1	.0619	136.9	13.69	1,044	---	---	13.69

[1] Based on $6 per man-hour, including fringe benefits.

[2] Based on $0.40 each for pallet and slipsheet.

TABLE 18.—*Total costs, including labor, equipment, materials, dunnage, and freight, of 4 systems for loading railcars with groceries* [1]

Load	Product category	Cases	Weight	Equipment			Dunnage		Total cost per—			Freight cost per—	
				Type	Hours required	Cost [2]	Code [3]	Cost	1,000 cases	1,000 lb	Load	100 lb	Load
		Number	*Pounds*		*Number*	*Dollars*		*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
					MANUAL LOADING								
33	Glass	1,952	50,300	Fork	1.85	3.13			18.67	0.725	36.45	1.22	614
34	High density	2,392	81,300	Clamp	2.08	5.20			17.83	.525	42.66	1.03	838
34A	do	1,416	50,500	Jack	2.37	2.13			11.53	.322	16.33	1.22	616
35	Plastic	3,718	81,800	do	2.70	2.43			13.71	.623	50.99	1.03	842
36	do	2,860	97,200	Clamp	2.18	5.45			15.64	.460	44.75	1.03	1,002
37	Paper/cereal	1,315	39,000	Jack	3.26	2.93			17.12	.577	22.52	1.49	581
38	do	1,085	33,800	Clamp	3.49	8.72			27.35	.878	29.68	1.49	504
38A	Bagged	1,157	58,900	Fork	3.04	5.14			20.23	.394	23.41	1.00	589
39	do	1,008	50,400	do	2.91	4.92			22.21	.444	22.39	1.00	504
	Average	1,878	60,400		2.65	4.45			17.11	.532	32.13	1.25	677
					PALLET LOADING								
24	Glass	2,112	76,100	Fork	1.87	3.16	A, F	8.50	15.56	.432	32.87	1.15	875
25	do	3,562	108,300	do	2.37	4.01	A, F	8.50	10.31	.339	36.72	.97	1,050
26	High density	2,572	102,800	do	2.22	3.75	A, F	11.80	20.26	.506	52.02	.97	997
27	do	6,368	129,800	do	2.39	4.04	B, C	23.75	9.78	.479	62.12	.92	1,194
28	do	6,113	122,300	do	2.98	5.04	B, C	23.75	10.91	.545	66.70	.92	1,125
29	Paper/cereal	1,199	38,100	do	1.32	2.23	A	3.60	25.41	.819	65.20	1.15	915
30	do	1,181	36,600	do	1.02	1.72	A	3.60	25.20	.864	69.07	1.15	919
31	do	1,707	42,700	do	1.77	2.99	A, F	33.80	24.83	.781	29.77	1.49	568
32	Plastic	2,566	79,600	do	1.98	3.35	A, F	26.80	23.25	.750	27.46	1.49	545
32A	do	2,740	79,900	do	2.48	4.19	A, F	26.80	41.37	1.654	70.62	1.49	636
	Average	3,012	81,600		2.04	3.45		17.09	17.01	.628	51.26	1.13	882
					SLIPSHEET LOADING								
40	Glass	1,416	50,000	P-Pac	1.08	2.41	A, F	9.00	20.56	.582	29.12	1.22	610
41	High density	2,780	94,500	Clamp	2.76	6.90	B, C	17.50	20.49	.603	56.97	1.03	973
42	do	2,540	106,700	do	3.04	7.60	B, C	17.50	23.37	.556	59.36	.97	1,035
46	Plastic	3,380	74,400	do	2.72	6.80	B, C	19.00	17.19	.781	58.09	1.15	856
47	do	2,780	61,600	do	2.34	5.85	B, C	19.00	16.57	.748	46.06	1.15	708
43	Paper/cereal	986	30,800	do	2.32	5.80	A	4.00	53.27	1.705	52.52	1.49	459

44	do	550	22, 200	do	.70	1.75	A	1.80	27.16	.673	14.94	1.49	331
45	do	3, 600	44, 000	do	1.84	4.60	D		8.79	.719	31.65	1.49	656
46A	do	550	22, 200	do	.81	2.02	A	1.62	44.51	1.103	24.48	1.49	331
47A	Bagged	960	48, 000	P-Pac	.96	2.14			17.19	.344	16.50	1.00	480
47B	do	950	45, 000	do	.80	1.78			16.40	.346	15.58	1.00	450
	Average	1, 863	54, 500		1.76	4.33		8.13	19.77	.676	36.84	1.14	626
	CLAMP LOADING												
48	High density	2, 780	94, 500	Clamp	2.64	6.60	B, C	19.00	14.91	.439	41.45	1.03	973
49	do	2, 540	106, 700	do	2.93	7.32	B, C	17.50	16.70	.398	42.42	.97	1, 035
50	Plastic	3, 380	74, 400	do	2.55	6.38	B, C	19.00	12.04	.547	40.69	1.15	856
51	do	2, 780	61, 600	do	2.23	5.58	B, C	17.50	13.11	.592	36.45	1.15	708
52	Paper/cereal	550	22, 200	do	.77	1.92	B	1.80	15.15	.375	8.33	1.49	331
53	do	986	30, 800	do	1.50	3.75	B	3.50	16.50	.528	16.27	1.49	459
54	do	3, 600	40, 800	do	2.40	6.00	D		5.68	.501	20.43	1.49	608
55	do	3, 195	35, 700	do	3.22	8.05	D		8.56	.766	27.35	1.49	532
	Average	2, 476	58, 300		2.28	5.70		9.78	11.78	.500	29.17	1.18	688

[1] Costs for labor and materials shown in table 17.
[2] Based on hourly cost for clamp forklift truck of $2.50, forklift truck $1.69, pallet jack $0.90, and Pull-Pac forklift truck $2.23.
[3] A=tape, B=string, C=bumpers, D=shrink film, F=divider panels.

TABLE 19.—*Labor and damage costs of 4 systems for unloading railcars with groceries*

Load	Product category	Cases	Weight	Unit load size	Crew size	Labor required per— Case	Labor required per— Load	Labor cost per load [1]	Man-hour productivity	Damage cost [2]	Total labor and damage cost per load
		Number	*Pounds*	*Number of cases*	*Number*	*Man-minutes*	*Man-minutes*	*Dollars*	*Number of cases*	*Dollars*	*Dollars*
	MANUAL UNLOADING										
1	Glass/high density	1, 913	63, 400	----------	2	0. 2240	428. 5	42. 85	268	48. 00	90. 85
3	do	2, 974	103, 900	----------	2	. 1927	573. 1	57. 31	311	----------	57. 31
4	Paper	618	39, 800	----------	2	. 3832	236. 8	23. 68	157	----------	23. 68
5	do	800	21, 600	----------	2	. 3674	293. 9	29. 39	163	----------	29. 39
6	do	1, 336	39, 700	----------	2	. 2081	278. 0	27. 80	288	----------	27. 80
7	Plastic	2, 732	79, 900	----------	3	. 3671	1, 002. 9	100. 29	163	----------	100. 29
8	do	2, 003	68, 100	----------	2	. 3305	662. 0	66. 20	181	----------	66. 20
10	Bagged	1, 036	51, 800	----------	2	. 2210	229. 0	22. 90	271	----------	22. 90
11	do	1, 008	50, 400	----------	2	. 2114	213. 1	21. 31	284	----------	21. 31
12	do	1, 005	46, 100	----------	1	. 1990	209. 9	20. 99	302	----------	20. 99
Average		1, 542	56, 500	----------	2	. 2704	412. 7	41. 27	239	4. 80	45. 27
	PALLET UNLOADING										
13	Glass	2, 808	113, 700	54	1	. 0210	59. 0	5. 90	2, 857	----------	5. 90
14	do	3, 000	99, 000	70	2	. 0748	224. 4	22. 44	802	----------	22. 44
15	High density	2, 354	124, 100	----------	3	. 1169	275. 2	27. 52	513	----------	27. 53
16	do	1, 972	55, 400	76	2	. 1208	238. 2	23. 82	497	8. 00	31. 82
17	do	2, 593	72, 600	128	3	. 0945	245. 0	24. 50	635	8. 00	32. 50
18	Paper/cereal	1, 920	53, 800	40	2	. 1189	228. 5	22. 85	504	----------	22. 85
19	Plastic	2, 780	61, 600	50	2	. 1140	316. 9	31. 69	526	----------	31. 69
20	Bagged	1, 698	52, 000	73	1	. 0463	78. 6	7. 86	1, 296	----------	7. 86
21	do	2, 194	64, 800	49	2	. 1269	278. 0	27. 80	474	----------	27. 80
Average		2, 369	77, 400	68	2	. 0927	216. 0	21. 60	900	1. 78	23. 38
	SLIPSHEET UNLOADING										
22	Glass	2, 836	41, 400	100	2	. 0407	115. 0	11. 50	1, 474	----------	11. 50
24	High density	1, 500	58, 200	60	2	. 0859	128. 8	12. 88	698	----------	12. 88
27	Paper/cereal	1, 595	25, 000	39	3	. 2108	336. 2	33. 62	285	----------	33. 62
30	do	800	73, 400	15	2	. 4015	321. 2	32. 12	149	24. 00	56. 12

31	Plastic	1, 736	60, 400	42	2	. 0821	142. 5	14. 25	731	8. 00	22. 25
33	Bagged	1, 055	46, 000	51	2	. 2207	232. 8	23. 28	272	----------	23. 28
34	do	1, 052	53, 500	51	2	. 0968	101. 8	10. 18	620	----------	10. 18
35	do	1, 008	50, 400	40	2	. 1575	158. 8	15. 88	381	----------	15. 88
36	do	1, 036	51, 800	40	3	. 1095	113. 4	11. 34	548	48. 00	59. 34
Average		1, 402	51, 100	49	2	. 1562	183. 4	18. 34	573	8. 89	27. 23
SHRINK FILM WRAP UNLOADING											
25	High density	2, 639	97, 000	75	2	. 0409	107. 9	10. 79	1, 467	----------	10. 79
26	Paper/cereal	1, 657	31, 400	36	2	. 0823	136. 4	13. 64	1, 364	----------	13. 64
28	do	1, 660	31, 600	36	2	. 0662	109. 9	10. 99	906	----------	10. 99
Average		1, 985	53, 300	49	2	. 0631	118. 1	11. 81	1, 246	----------	11. 81

[1] Based on $6 per man-hour, including fringe benefits.
[2] Based on $8 per case.

TABLE 20.—*Total costs, including labor, equipment, and damage, of 4 systems for unloading railcars with groceries*[1]

Load	Product category	Cases	Weight	Equipment			Dunnage code[3]	Total cost per—		
				Type	Hours required	Cost[2]		1,000 cases	1,000 lb	Load
		Number	Pounds		Number	Dollars		Dollars	Dollars	Dollars
				MANUAL UNLOADING						
1	Glass	1, 913	63, 400	Jack	3. 57	3. 21		49. 17	1. 484	94. 06
3	High density	2, 974	103, 900	do	3. 11	2. 80		20. 21	. 579	60. 11
4	Paper	618	39, 800	do	1. 97	1. 77		41. 18	. 639	25. 45
5	do	800	21, 600	do	2. 45	2. 20		39. 49	1. 462	31. 59
6	do	1, 336	39, 700	do	2. 32	2. 09		22. 37	. 753	29. 89
7	Plastic	2, 732	79, 900	do	5. 72	5. 15	B, C	38. 59	1. 320	105. 44
8	do	2, 003	68, 100	do	5. 52	4. 97		35. 53	1. 045	71. 17
10	Bagged	1, 036	51, 800	do	2. 54	2. 29		24. 31	. 486	25. 19
11	do	1, 008	50, 400	do	1. 78	1. 60		22. 73	. 454	22. 91
12	do	1, 005	46, 100	do	3. 50	3. 15		24. 02	. 524	24. 14
Average		1, 542	56, 500		3. 25	2. 92		31. 37	. 867	48. 99
				PALLET UNLOADING						
13	Glass	2, 808	113, 700	Fork	. 98	1. 66	A	2. 69	. 066	7. 56
14	do	3, 000	99, 000	do	1. 87	3. 16	A	8. 53	. 259	25. 60
15	High density	2, 354	124, 100	do	1. 53	2. 59		12. 79	. 243	30. 11
16	do	1, 972	55, 400	do	1. 98	3. 35	A	17. 83	. 322	35. 17
17	do	2, 593	72, 600	do	1. 36	2. 30	A	12. 98	. 479	34. 80
18	Paper/cereal	1, 920	53, 800	do	1. 27	2. 15	A	13. 42	. 465	25. 00
19	Plastic	2, 780	61, 600	do	3. 52	5. 95	A	13. 51	. 611	37. 64
20	Bagged	1, 696	52, 000	do	1. 31	2. 21		5. 94	. 194	10. 07
21	do	2, 194	64, 800	do	2. 32	3. 92		14. 46	. 490	31. 72
Average		2, 369	77, 400		1. 79	3. 03		11. 15	. 341	26. 41
				SLIPSHEET UNLOADING						
22	Glass	2, 836	41, 400	P–Pac	. 96	2. 14	E	4. 81	. 329	13. 64
24	High density	1, 500	58, 200	do	1. 07	2. 39	A	10. 18	. 262	15. 27
27	Paper/cereal	1, 595	25, 000	do	1. 87	4. 17	A	23. 69	1. 506	37. 79
30	do	860	73, 400	do	1. 53	3. 41	A	74. 41	. 811	59. 53
31	Plastic	1, 736	60, 400	do	1. 19	2. 65	B, C	14. 34	. 412	24. 90

33	Bagged	1,055	46,000	do	1.94	4.33		26.17	.600	27.61
34	do	1,052	53,500	do	.85	1.90		11.48	.226	12.08
35	do	1,008	50,400	do	.88	1.96		17.70	.354	17.84
36	do	1,036	51,800	Clamp	1.58	3.95	A, C	61.04	1.221	63.29
	Average	1,402	51,100		1.32	2.98		21.55	.591	30.21
	SHRINK FILM WRAP UNLOADING									
25	High density	2,639	97,000	P-Pac	.90	2.01	D	4.85	.132	12.81
26	Paper/cereal	1,657	31,400	do	1.15	2.56	D	9.78	.516	16.20
28	do	1,660	31,600	do	.92	2.05	D	7.86	.413	13.05
	Average	1,985	53,300		99	2.21		7.06	.263	14.01

[1] Costs for labor and damage shown in table 19.
[2] Based on hourly cost for clamp forklift truck of $2.50, forklift truck $1.69, pallet jack $0.90, and Pull-Pac forklift truck $2.23.
[3] A=tape, B=string, C=bumpers, D=shrink film, E=Avistrap.

TABLE 21.—*Labor and materials costs of 4 systems for loading trucks with groceries*

Load	Product category	Cases	Weight	Unit load size	Crew size	Labor required per— Case	Labor required per— Load	Labor cost per load [1]	Man-hour productivity	Materials Amount	Materials Cost [2]	Total labor and materials cost per load
		Number	*Pounds*	*Number of cases*	*Number*	*Man-minutes*	*Man-minutes*	*Dollars*	*Number of cases*	*Number*	*Dollars*	*Dollars*
	MANUAL LOADING											
11	Glass	1,627	41,900		3	0.1809	294.3	29.43	332			29.43
12	do	1,200	41,000		2	.1505	180.6	18.06	399			18.06
13	High density	2,130	42,000		2	.1122	239.0	23.90	535			23.90
14	do	1,370	27,500		2	.0972	133.2	13.32	617			13.32
15	Plastic	1,235	42,000		2	.1088	134.4	13.44	551			13.44
16	do	1,000	40,000		2	.1319	131.9	13.19	445			13.19
17	Paper	500	24,700		2	.1918	95.9	9.59	313			9.59
18	Bagged	840	42,000		2	.1604	134.7	13.47	374			13.47
	Average	1,238	37,600		2	.1417	168.0	16.80	446			16.80

See footnotes at end of table.

TABLE 21.—*Labor and materials costs of 4 systems for loading trucks with groceries*—Continued

Load	Product category	Cases	Weight	Unit load size	Crew size	Labor required per— Case	Labor required per— Load	Labor cost per load [1]	Man-hour productivity	Materials— Amount	Materials— Cost [2]	Total labor and materials cost per load
		Number	*Pounds*	*Number of cases*	*Number*	*Man-minutes*	*Man-minutes*	*Dollars*	*Number of cases*	*Number*	*Dollars*	*Dollars*
	PALLET LOADING											
1	Glass	972	44, 300	54	1	. 0240	23. 3	2. 33	2, 500	18	7. 20	9. 53
2	do	2, 285	42, 000	127	1	. 0115	26. 3	2. 63	5, 217	18	7. 20	9. 83
3	do	1, 870	40, 300	110	1	. 0161	30. 1	3. 01	3, 727	16	6. 40	9. 41
4	High density	2, 100	27, 700	165	1	. 0113	23. 7	2. 37	5, 310	13	5. 20	7. 57
5	do	3, 320	37, 700	166	1	. 0167	55. 4	5. 54	3, 593	20	8. 00	13. 54
6	do	2, 130	45, 200	38	1	. 0261	55. 6	5. 56	2, 299	56	14. 00	19. 56
7	do	1, 800	49, 500	100	1	. 0141	25. 4	2. 54	4, 255	18	7. 20	9. 74
8	Plastic	1, 500	40, 000	56	1	. 0245	36. 8	3. 68	2, 449	27	10. 80	14. 48
9	Bagged	800	40, 000	40	1	. 0233	16. 8	1. 68	2, 575	20	8. 00	9. 68
10	do	720	43, 900	30	1	. 0310	22. 3	2. 23	1, 935	24	9. 60	11. 83
	Average	1, 750	41, 100	89	1	. 0199	31. 6	3. 16	3, 386	23	8. 36	11. 52
	SHRINK FILM WRAP LOADING											
19	High density	1, 800	49, 500	100	1	. 0152	27. 4	2. 74	3, 947	18	7. 20	9. 94
20	do	3, 320	37, 700	160	1	. 0132	43. 8	4. 38	4, 545	20	8. 00	12. 38
20A	Bagged	960	28, 820	60	1	. 0246	23. 6	2. 36	2, 439	20	8. 00	10. 36
	Average	2, 027	38, 700	107	1	. 0177	31. 6	3. 16	3, 644	19	7. 73	10. 89
	CLAMP LOADING											
21	High density	2, 000	40, 000	90	1	. 0245	49. 0	4. 90	2, 449			4. 90
22	Paper	500	24, 700	33	1	. 0513	25. 6	2. 56	2, 643			2. 56
23	Plastic	1, 000	39, 100	50	1	. 0227	22. 7	2. 27	1, 170			2. 27
	Average	1, 167	34, 600	58	1	. 0328	32. 4	3. 24	2, 087			3. 24

[1] Based on $6 per man-hour, including fringe benefits.
[2] Based on $0.40 each for pallet and slipsheet.

TABLE 22.—*Total costs, including labor, equipment, materials, dunnage, and freight, of 4 systems for loading trucks with groceries*[1]

Load	Product category	Cases	Weight	Equipment			Dunnage		Total cost per—			Freight cost per—	
				Type	Hours required	Cost[2]	Code[3]	Cost	1,000 cases	1,000 lb	Load	100 lb	Load
		Number	*Pounds*		*Number*	*Dollars*		*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
	MANUAL LOADING												
11	Glass	1,627	41,900	Fork	1.63	2.75			19.77	0.768	32.18	1.72	721
12	do	1,200	41,000	do	2.54	4.29			18.62	.545	22.35	1.72	705
13	High density	2,130	42,000	do	3.09	5.22			13.67	.693	29.12	1.72	722
14	do	1,370	27,500	Clamp	2.06	5.15			13.48	.672	18.47	1.72	473
15	Plastic	1,235	42,000	do	1.71	4.28			14.35	.422	17.72	1.72	722
16	do	1,000	40,000	do	1.91	4.78			17.97	.449	17.97	1.72	688
17	Paper	500	24,700	do	1.24	3.10			25.38	.514	12.69	1.72	425
18	Bagged	840	42,000	Fork	2.00	3.38			20.06	.401	16.85	1.72	722
	Average	1,238	37,600		2.02	4.12			16.90	.556	20.92	1.72	647
	PALLET LOADING												
1	Glass	972	44,300	Fork	.39	.66			10.48	.230	10.19	1.72	742
2	do	2,285	42,000	do	.44	.74			24.15	.252	10.57	1.72	704
3	do	1,870	40,300	do	.50	.84			5.48	.254	10.25	1.72	674
4	High density	2,100	27,700	Clamp	.40	1.00	A	1.30	4.70	.356	9.87	1.72	467
5	do	3,320	37,700	do	.92	2.30	A	2.00	5.37	.473	17.84	1.72	639
6	do	2,130	45,200	Fork	.93	1.57	A	3.92	11.76	.554	25.05	1.72	780
7	do	1,800	49,500	do	.42	.71	G	1.62	6.71	.244	12.07	1.72	826
8	Plastic	1,500	40,000	do	.61	1.03			10.34	.388	15.51	1.72	683
9	Bagged	800	40,000	P-Pac	.28	.62			12.88	.258	10.30	1.72	676
10	do	720	43,900	do	.37	.82			17.57	.288	12.65	1.72	744
	Average	1,750	41,100		.53	1.03		.88	7.67	.327	13.43	1.72	694
	SHRINK FILM WRAP LOADING												
19	High density	1,800	49,500	Fork	.46	.78	G		5.96	.217	10.72	1.72	851
20	do	3,320	37,700	do	.73	1.23	D	20.00	10.12	.892	33.61	1.72	648
20A	Bagged	960	28,820	do	.39	.66	D	20.00	32.31	1.077	31.02	2.50	720
	Average	2,027	38,700		.53	.89		13.33	12.39	.650	25.12	1.98	740

See footnotes at end of table.

TABLE 22.—*Total costs, including labor, equipment, materials, dunnage, and freight, of 4 systems for loading trucks with groceries*[1]—Continued

Load	Product category	Cases	Weight	Equipment			Dunnage		Total cost per—			Freight cost per—	
				Type	Hours required	Cost[2]	Code[3]	Cost	1,000 cases	1,000 lb	Load	100 lb	Load
		Number	*Pounds*		*Number*	*Dollars*		*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
				CLAMP LOADING									
21	High density	2,000	40,000	Clamp	.82	2.05	A	2.20	4.58	.229	9.15	1.72	688
22	Paper	500	24,700	do	.43	1.08			3.64	.093	3.64	1.72	673
23	Plastic	1,000	39,100	do	.38	.95			6.44	.130	3.22	2.50	618
	Average	1,167	34,600		.54	1.36		.73	4.57	.154	5.34	1.98	660

[1] Costs for labor and materials shown in table 21.
[2] Based on hourly cost for clamp forklift truck of $2.50, forklift truck $1.69, pallet jack $0.90, and Pull-Pac forklift truck $2.23.
[3] A=tape, D=shrink film, G=case shrink film.

TABLE 23.—*Fixed cost per hour for grocery delivery equipment*

Item	Diesel tractor	45-ft trailer	Total
Purchase cost	$40,000	$10,000	$50,000
Salvage value[1]	6,000	600	6,600
Annual depreciation[2]	5,667	1,175	6,842
Annual interest cost[3]	1,725	398	2,123
Total annual cost	7,392	1,573	8,965
Fixed cost per hour[4]	1.78	.38	2.16

[1] Based on 15 pct of purchase price for tractor and 6 pct for trailer.
[2] Straight line depreciation—purchase cost minus salvage value divided by average life (6 yr for tractor and 8 yr for trailer).
[3] Purchase cost plus salvage value divided by 2 equals average investment times 7.5-pct interest equals annual interest cost.
[4] Annual cost divided by annual time in use based on 4,160 hr annually for tractor and trailer.

TABLE 24.—*Labor and damage costs of 4 systems for unloading trucks with groceries*

Load	Product category	Cases	Weight	Unit load size	Crew size	Labor required per— Case	Labor required per— Load	Labor cost per load [1]	Man-hour productivity	Damage cost [2]	Total labor and damage cost per load
		Number	*Pounds*	*Number of cases*	*Number*	*Man-Minutes*		*Dollars*	*Number of cases*	*Dollars*	*Dollars*
				MANUAL UNLOADING							
38	Glass	1, 000	38, 500		2. 0	0. 2348	235. 0	23. 50	256		23. 50
39	do	1, 520	41, 000		1. 6	. 2476	376. 3	37. 60	242		37. 60
40	do	1, 040	43, 600		1. 3	. 1939	201. 6	20. 16	309		20. 16
41	High density	1, 134	36, 900		1. 3	. 1973	224. 2	22. 42	304		22. 42
43	do	950	39, 100		2. 1	. 2940	279. 3	27. 93	204		27. 93
44	Plastic	750	24, 400		1. 7	. 3120	234. 0	23. 40	192	24. 00	47. 40
45	do	1, 344	40, 900		1. 1	. 4038	542. 7	54. 27	145		54. 27
46	Paper/cereal	1, 232	23, 500		1. 4	. 2146	264. 4	26. 44	280		26. 44
47	do	1, 282	26, 000		1. 2	. 1747	224. 0	22. 40	343		22. 40
48	Bagged	670	40, 000		1. 2	. 2181	146. 1	14. 61	275		14. 61
49	do	698	34, 800		1. 2	. 2576	179. 8	17. 98	233	24. 00	41. 98
Average		1, 056	35, 300		1. 5	. 2498	264. 3	26. 43	253	4. 36	30. 79
				PALLET UNLOADING							
50	Glass	1, 157	24, 600	128	1. 7	. 0440	50. 9	5. 09	1, 364		5. 09
51	do	1, 080	42, 100	60	1. 0	. 0266	28. 7	2. 87	2, 256		2. 87
52	do	1, 025	28, 700	43	1. 0	. 0496	50. 8	5. 08	1, 210	56. 00	61. 08
53	do	1, 080	39, 000	44	1. 0	. 0364	39. 7	3. 97	1, 648		3. 97
54	High density	856	32, 000	61	1. 0	. 0242	28. 8	2. 88	2, 479		2. 88
55	do	2, 135	42, 600	125	1. 0	. 0129	27. 5	2. 75	4, 651		2. 75
56	do	1, 800	41, 100	100	1. 0	. 0143	25. 7	2. 57	4, 196		2. 57
57	Plastic	1, 295	16, 500	68	1. 0	. 0140	18. 1	1. 81	4, 286		1. 81
58	do	1, 260	27, 700	55	1. 0	. 0200	25. 2	2. 52	3, 000		2. 52
60	Paper	845	33, 800	32	1. 0	. 0407	34. 4	3. 44	1, 474		3. 44
61	Bagged	540	32, 400	30	1. 3	. 0713	38. 5	3. 85	842		3. 85
62	do	510	42, 700	25	1. 0	. 0388	19. 8	1. 98	1, 546	16. 00	17. 98
63	do	720	43, 900	30	1. 0	. 0337	24. 2	2. 42	1, 780		2. 42
Average		1, 100	34, 400	62	1. 1	. 0328	31. 7	3. 17	2, 364	5. 54	8. 71

See footnotes at end of table.

TABLE 24.—*Labor and damage costs of 4 systems for unloading trucks with groceries*—Continued

Load	Product category	Cases	Weight	Unit load size	Crew size	Labor required per— Case	Labor required per— Load	Labor cost per load [1]	Man-hour productivity	Damage cost [2]	Total labor and damage cost per load
		Number	*Pounds*	*Number of cases*	*Number*	*Man-Minutes*		*Dollars*	*Number of cases*	*Dollars*	*Dollars*
SLIPSHEET UNLOADING											
64	Glass	1,520	41,000	64	2.0	.0648	98.5	9.85	926	----------	9.85
65	do	1,080	40,000	60	2.3	.1272	137.4	13.74	472	8.00	21.74
Average		1,300	40,500	62	2.2	.0960	118.0	11.80	699	4.00	15.80
SHRINK FILM WRAP UNLOADING											
66	Glass	920	42,200	55	1.0	.0329	30.3	3.03	1,823	----------	3.03
67	do	675	28,800	45	1.0	.0335	22.6	2.26	1,791	----------	2.26
68	High density	1,120	36,900	80	1.0	.0172	19.6	1.96	3,488	----------	1.96
69	do	1,700	39,200	100	1.3	.0200	33.7	3.37	3,000	----------	3.37
70	do	1,800	41,100	100	1.0	.0134	24.1	2.41	4,478	----------	2.41
71	Bagged	960	28,800	60	1.0	.0327	31.4	3.14	1,835	----------	3.14
72	do	960	28,800	60	1.3	.0309	29.7	2.97	1,942	----------	2.97
Average		1,162	35,100	71	1.1	.0258	27.3	2.73	2,622	----------	2.73

[1] Based on $6 per man-hour, including fringe benefits.
[2] Based on $8 per case.

TABLE 25.—*Total costs, including labor, equipment, and damage, of 4 systems for unloading trucks with groceries*[1]

Load	Product category	Cases	Weight	Equipment			Dunnage code[3]	Total cost per—		
				Type	Hours required	Cost[2]		1,000 cases	1,000 lb	Load
		Number	*Pounds*		*Number*	*Dollars*		*Dollars*	*Dollars*	*Dollars*
				MANUAL UNLOADING						
38	Glass	1,000	38,500	Jack	1.98	1.78	E	25.28	0.657	25.28
39	do	1,520	41,000	Fork	3.80	6.42		28.96	.706	44.02
40	do	1,040	43,600	do	2.58	4.36		23.58	.562	24.52
41	High density	1,134	36,900	do	2.80	4.73		23.94	.736	27.15
43	do	950	39,100	Jack	2.17	1.95		31.45	.765	29.88
44	Plastic	750	24,400	do	2.33	2.10		66.00	2.029	49.50
45	do	1,344	40,900	Fork	7.89	13.33		50.30	1.653	67.60
46	Paper/cereal	1,232	23,500	do	3.24	5.48	A	25.91	1.358	31.92
47	do	1,282	26,000	Jack	3.17	2.85		19.70	.971	25.25
48	Bagged	670	40,000	Fork	1.95	3.30		26.73	.448	17.91
49	do	698	34,800	do	2.50	4.22		66.19	1.328	46.20
Average		1,056	35,300		3.13	4.59		33.50	1.002	35.38
				PALLET UNLOADING						
50	Glass	1,157	24,600	Jack	.50	.45		4.79	.225	5.54
51	do	1,080	42,100	Fork	.48	.81	A	3.41	.087	3.68
52	do	1,025	28,700	Jack	.85	.76	A	60.33	2.155	61.84
53	do	1,080	39,000	Fork	.67	1.13		4.72	.131	5.10
54	High density	856	32,000	Jack	.48	.43		3.87	.103	3.31
55	do	2,135	42,600	Fork	.47	.79	B, C	1.65	.083	3.54
56	do	1,800	41,100	do	.43	.73		1.83	.083	3.30
57	Plastic	1,295	16,500	do	.30	.51		1.79	.141	2.32
58	do	1,260	27,700	do	.42	.71		2.56	.117	3.23
60	Paper	845	33,800	do	.57	.96		5.21	.130	4.40
61	Bagged	540	32,400	Jack	.26	.23		7.56	.126	4.08
62	do	510	42,700	Fork	.33	.56		36.35	.434	18.54
63	do	720	43,900	do	.40	.68		4.31	.071	3.10
Average		1,100	34,400		.47	.67		8.52	.272	9.38

See footnotes at end of table.

TABLE 25.—*Total costs, including labor, equipment, and damage, of 4 systems for unloading trucks with groceries*[1]—Continued

Load	Product category	Cases	Weight	Equipment: Type	Equipment: Hours required	Equipment: Cost [2]	Dunnage code [3]	Total cost per—: 1,000 cases	Total cost per—: 1,000 lb	Total cost per—: Load
		Number	*Pounds*		*Number*	*Dollars*		*Dollars*	*Dollars*	*Dollars*
	SLIPSHEET UNLOADING									
64	Glass	1, 520	41, 000	P–Pac	. 82	1. 83	A	7. 68	. 285	11. 68
65	do	1, 080	40, 000	do	. 98	2. 19	A	22. 16	. 598	23. 93
Average		1, 300	40, 500		. 90	2. 01		13. 70	. 440	17. 80
	SHRINK FILM WRAP UNLOADING									
66	Glass	920	42, 200	Fork	. 50	. 84	D	4. 21	. 092	3. 87
67	do	675	28, 800	do	. 78	1. 32	D	5. 30	. 124	3. 58
68	High density	1, 120	36, 900	do	. 33	. 56	D	2. 25	. 068	2. 52
69	do	1, 700	39, 200	Jack	. 42	. 38	D	2. 21	. 096	3. 75
70	do	1, 800	41, 100	Fork	. 40	. 68	D	1. 72	. 075	3. 09
71	Bagged	960	28, 800	do	. 52	. 88	D	4. 19	. 140	4. 02
72	do	960	28, 800	Jack	. 37	. 33	D	3. 71	. 114	3. 30
Average		1, 162	35, 100		. 47	. 71		2. 96	. 098	3. 45

[1] Costs for labor and damage shown in table 24.

[2] Based on hourly cost for clamp forklift truck of $2.50, forklift truck $1.69, pallet jack $0.90, and Pull-Pac forklift truck $2.23.

[3] A=tape, B=string, C=bumpers, D=shrink film, E=Avistrap.

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